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# SCIENCE *and* SCIENTISTS *in the* NETHERLANDS INDIES


FIGURE 1. — CAMP OF THE DUTCH CENTRAL SUMATRA EXPEDITION OF 1877/79 NEAR THE SUMMIT OF MOUNT KERINTJI IN CENTRAL SUMATRA (from VETH's "Midden Sumatra I, 1881").

# SCIENCE *and* SCIENTISTS *in the* NETHERLANDS INDIES

*edited by*


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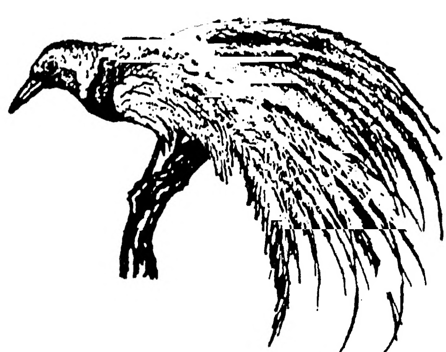


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*IN FINIBUS MALESIACIS*

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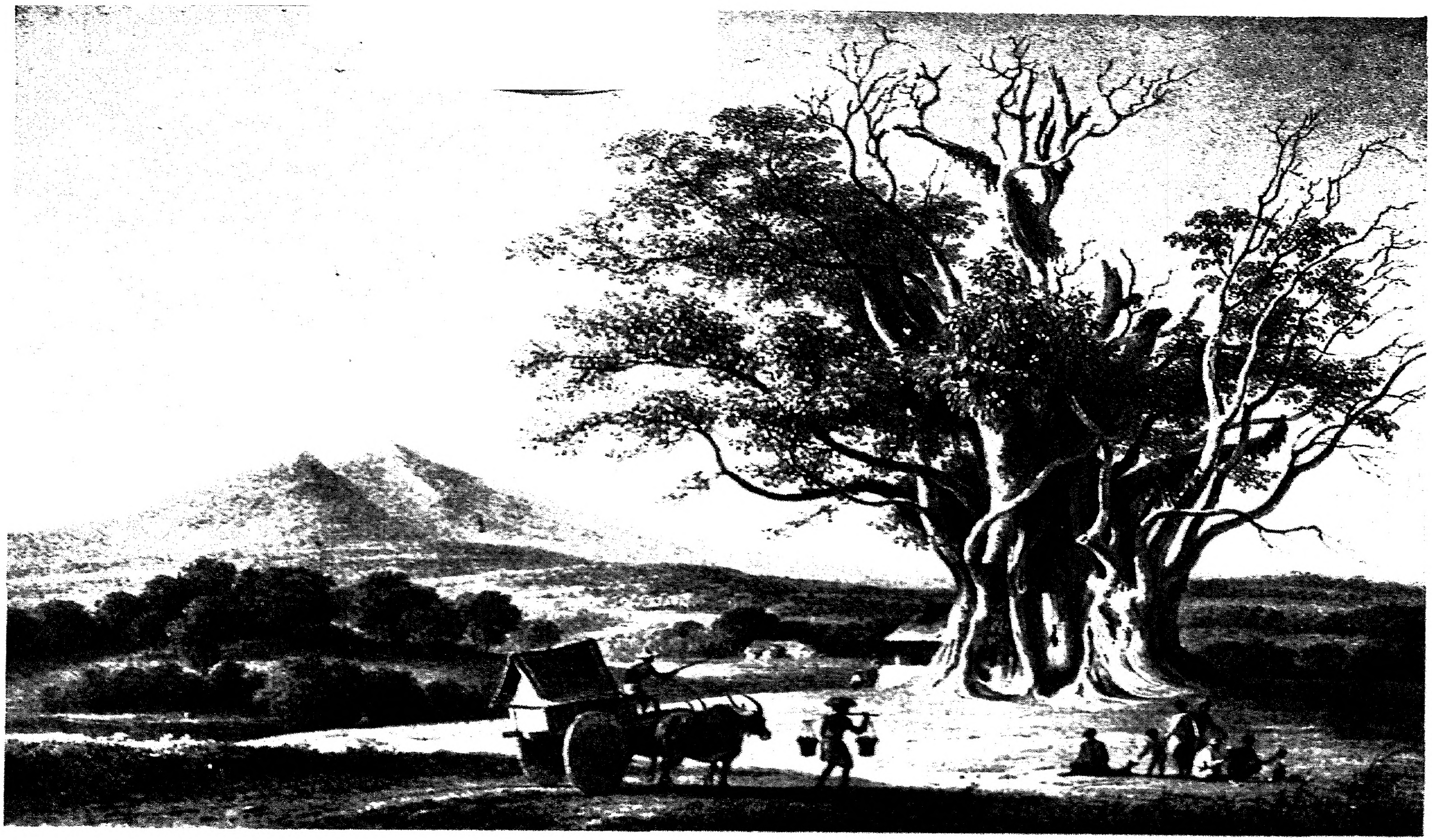

PLATE 2. — LANDSCAPE WITH FICUS NEAR BUITENZORG IN THE EARLY NINETEENTH CENTURY: "Batu-Tulis prope Bogor cum arbore Fici vetustissima," Tab. 11 by PAYEN (lithographed by LAUTERS) from BLUME's *Rumphia* (1835).

# EDITORS' FOREWORD

*In this volume,* "Science and Scientists in the Netherlands Indies," *we have endeavoured to present a picture of the development and status of a number of branches of the natural sciences, pure and applied, in the Netherlands Indies. The period during which this volume was prepared has been darkened by the military occupation of both the Indies and the mother country. This circumstance made it impossible to obtain the degree of collaboration necessary for a really complete history of science in the Netherlands Indies.*

*The present work consists of:*

1) *Original articles, prepared especially for this volume, dealing with the development or status of various branches of science in the Netherlands Indies.*
2) *Reprints of similar accounts previously published elsewhere, several of which originally appeared in Dutch and are now being made available in English.*
3) *A number of travel accounts and impressions by distinguished visitors in the past, often offering delightful glimpses (scientific and otherwise) of life and nature in the Netherlands Indies.*
4) *A number of shorter articles — notes, biographical sketches, reviews, etc. ("Serta Malesiana") — comprising material often of interest from the viewpoint of the promotion of North American-Netherlands Indies relationships.*
5) *A list of scientific institutions, societies, and workers in the Netherlands Indies at the time of the Japanese invasion.*

*Although this volume offers much less than might be expected from a complete history, it nevertheless presents certain information which would not ordinarily be contained in such a work. It is hoped that our effort will be of use and interest to visiting civilians and members of the armed forces of North America, Great Britain, and other countries; many of these visitors are now receiving their first impressions of the Malaysian archipelago, hitherto a strange and distant land for most of them. Dr.* GEORGE SARTON, *reviewing* VLEKKE'*s* Nusantara (*Isis 35:77, 1944*) *declared: "My only regret is that the students of natural history are neglected.* RUMPHIUS, *one of the greatest heroes of the East Indies, is dismissed in a few words; other naturalists are disposed of in a footnote; the history of the famous garden of Buitenzorg is not told, etc. It is true the author refers to* CHRISTIAAN EIJKMAN, *the pioneer of vitamin research, but that is not enough. The scientific exploration of the East Indies is not explained as it should be and thus some of the brightest pages of Dutch history are left out."*

*Although this volume is published by the Government of the Netherlands Indies, it aims to be much more than a government-inspired effort in a critical period. The editors have made every attempt to keep the work free of narrow political considerations, and laudatory statements concerning Dutch policies in the past have often been removed from the text. On the other hand, the editors believe that in the modern world science and government can not be kept entirely separate, and many chapters report on the relations between the two, which were perhaps closer in the Netherlands Indies than in many other parts of the world.*

*The history of science in the Netherlands Indies during the nineteenth and early twentieth centuries is a remarkable illustration of international coöperation in science. Scientists of numerous nationalities came to the Indies to study for a longer or a shorter time, or to settle down and make a career. Until about 1930 the Netherlands Indies were free of any narrow nationalistic concepts, and there was never any discrimination against foreign research workers nor any prejudice against the free expression of international coöperation; the Dutch have held and always will hold with* ALBERT VERWEY's *words, "De wetenschap heeft geen gevaarlijker vijand dan de aanmatiging van een exclusief nationalisme."*

*At the end of this volume a list of research workers in the Netherlands Indies at the time of the Japanese invasion is given. Their number may seem impressive (even though our list includes fewer routine workers than certain other lists of this type); however, it should be realized that the number of workers engaged in research in the strictest sense of the word has never exceeded a few hundred. The achievements of this small group are due to the fact that the majority of them had studied abroad and had been selected with unusual care.*

*The scientists, of many different nationalities, who came to the Netherlands Indies had varying educational backgrounds. Without doubt this diversity has exercised a stimulating influence, resulting in greater originality and initiative than would have been found in a group of individuals of less diverse backgrounds and origin. As a result of such various backgrounds, close ties were developed between scientists and research institutions in the Netherlands Indies and those of other parts of the world; these ties have been of the greatest benefit to us.*

*Scientific research has contributed substantially to the development of the Netherlands Indies, as the senior editor has shown in more detail in an article in* Nature *(151: 242–244, 1943). Many examples of this contribution are given in the present volume, the influence of research having been especially noteworthy in the fields of public health, estate agriculture, and applied geology.*

*Agricultural research has for the greater part been carried on through private institutions, but these institutions have devoted much of their effort to basic research. The findings of experiment stations have been quickly applied to estate agriculture in the East Indies; a close and well organized coöperation between research and practice has been of tremendous importance to all concerned.*

*The experiment stations, in addition to their numerous purely scientific and technical publications, organized extension and information services which issued less technical bulletins and leaflets. These services actively coöperated with various societies of plantation workers, often helping in the preparation of programmes of meetings and conventions. There has always been an unusual interest among plantation employees and other European workers, even among those without college training, in the scientific periodicals published in the Netherlands Indies (cf. p. 464). A large percentage of the circulation of these periodicals was among the quarter million Europeans living in the Netherlands Indies. At the time of the Japanese invasion, 10 journals or serials devoted to agriculture and related subjects were issued, 4 devoted to medicine and pharmacy, 2 to veterinary science and practice, and 7 to general science. There was also a number of engineering journals, one of them divided into several sections. These figures show that the occidentals in the East Indies, especially those engaged in the fields of agriculture, public health, and industry, had a great interest in their profession and its advances. Almost every employee of a*

*western enterprise subscribed to one or two technical journals in his field. Consequent to this interest, the research workers in the Netherlands Indies received a strong stimulus, and most of them had a definite feeling (which we do not find everywhere) that their work was really bearing fruit.*

*The natural sciences are, without doubt, essential to the cultural and material development of a country. It should be recognized that the scientific work referred to above and in the following pages is based for the greater part on the methods and results of "western science." This kind of work and research may often seem alien to the East, and to some it may seem somewhat arbitrarily transplanted to oriental surroundings, but nevertheless it has been of great benefit to the people of the Malaysian islands.*

*At the present time, when the right of peoples to self-government is being so much discussed, we may be permitted to ask whether scientific studies should be pursued in the same way as in the past — in a part of the world where nature and custom do not inevitably impel the rational recognition and application of facts established by the pure and applied sciences. To the implied question — namely, whether or not the occidental has the right and duty to continue his work as in the past — this book may offer a partial reply.*

*Only modern research can answer today's demand for a higher level of material well-being, for "freedom from want," that now basic governmental principle in every country where living standards are diverse. Only modern research seems able to help eradicate the poverty and privation among large groups of the population in many countries — a poverty and privation which would seem fundamentally unnecessary in this twentieth century. Science and its exponents will doubtless continue to have a great mission in the Far East.*

*We hope that there may be, among readers of this volume, some who will feel drawn toward the Malaysian islands, some who will feel that they have a training and knowledge which can be used there for the good of mankind. We also trust, and confidently, that the spirit of humanism and honest internationalism, unhampered by prejudices of race, creed, or personality, will guide the future of science and its applications in the Netherlands Indies.*


[illegible] Netherlands Indies [illegible] "De eerste Schipvaert der Hollandsche Natie naer Oost-Indien" [illegible] "Begin ende Voortgangh van de Vereenighde Nederlantsche geoctroyeerde Oost-Indische Compagnie" (1646). — Courtesy Arnold Arboretum of Harvard University.

# ACKNOWLEDGMENTS


The Editors of "Science and Scientists in the Netherlands Indies" would like to express their appreciation for the assistance and advice rendered by a number of colleagues. Mrs. J. A. C. FAGGINGER AUER (Belmont, Mass.), Dr. LILY M. PERRY (Arnold Arboretum of Harvard University) and Dr. D. J. STRUIK (Massachusetts Institute of Technology) translated several of the articles in this volume. Most of the proofs were faithfully read and checked by Mrs. F. VERDOORN, Phil. nat. dra., Associate Editor of CHRONICA BOTANICA, assisted by Miss LOLA E. WILSON and K. WALTER BARON, Bibliographer of CHRONICA BOTANICA. In addition to the numerous correspondents in the United States, Great Britain and Australia who helped us with the preparation of the address lists (*cf.* p. 425) we should like to extend sincere thanks for their disinterested help in the planning and editing of this volume to:

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The endpapers have been designed by Dr. ERWIN RAISZ of the Institute of Geographical Exploration of Harvard University. The vignettes of Malaysian animals have been drawn by Lieutenant ANTHONY DE VOS and are being reproduced by the kind permission of the Editor of *Nature Magazine*. The Netherlands Information Bureau of New York City has been very helpful in supplying us with suitable illustrations. Many of the older prints which we have reproduced have been taken from material kindly lent by the Library of the Arnold Arboretum of Harvard University. This library has a unique collection of Malaysian literature and has often been consulted in the course of the preparation of this volume.


A number of the articles in this volume have previously been published elsewhere. Some were originally published in Dutch and have now been translated into English (*cf.* p. vii). In certain cases the English of articles previously published in Netherlands or Netherlands Indies periodicals has been improved somewhat, but only insofar as the unwritten rules of bibliography permit. The spelling of scientific (plant and animal) names has been corrected in several instances but in the case of literatim reprints we have, of course, not tried to bring "old-fashioned" names in conformity with today's rules of scientific nomenclature. Place names have, as a rule, also been left in the form in which they were given in the original publications. In most cases the typographical style of material which has appeared in print before has been made uniform with that followed in the present volume; in a few cases, however, we felt that it was better to retain the style of the original publication.


FIGURE 4. — BATAVIA IN THE SEVENTEENTH CENTURY (from JOHAN NIEUHOF'S "Zee en Lantreize," 1682).

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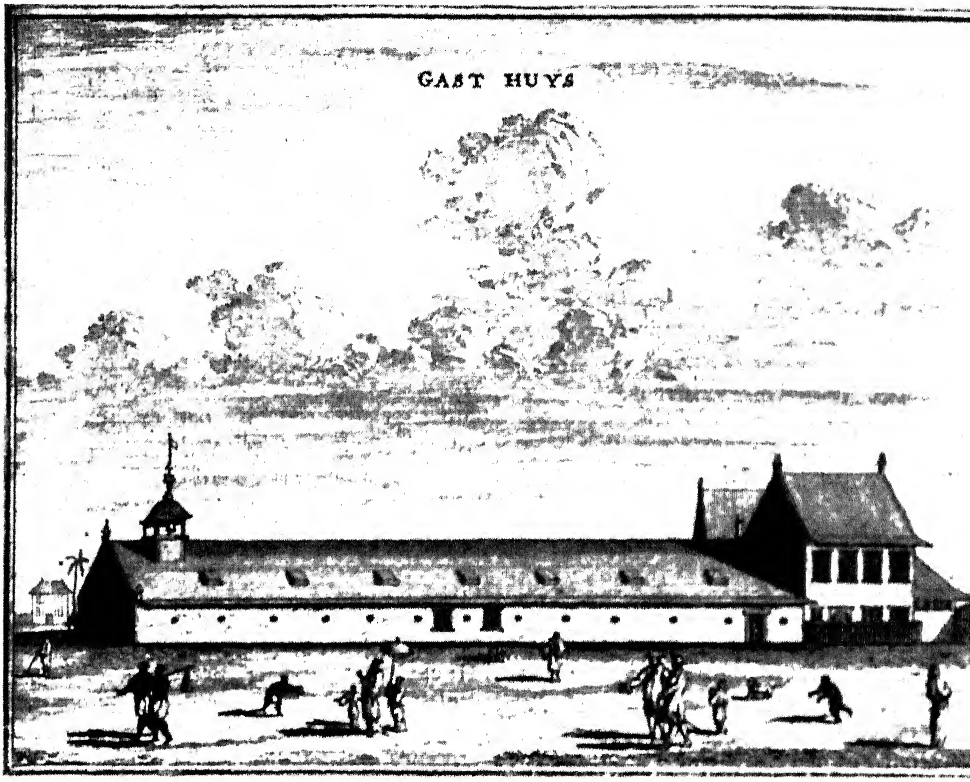


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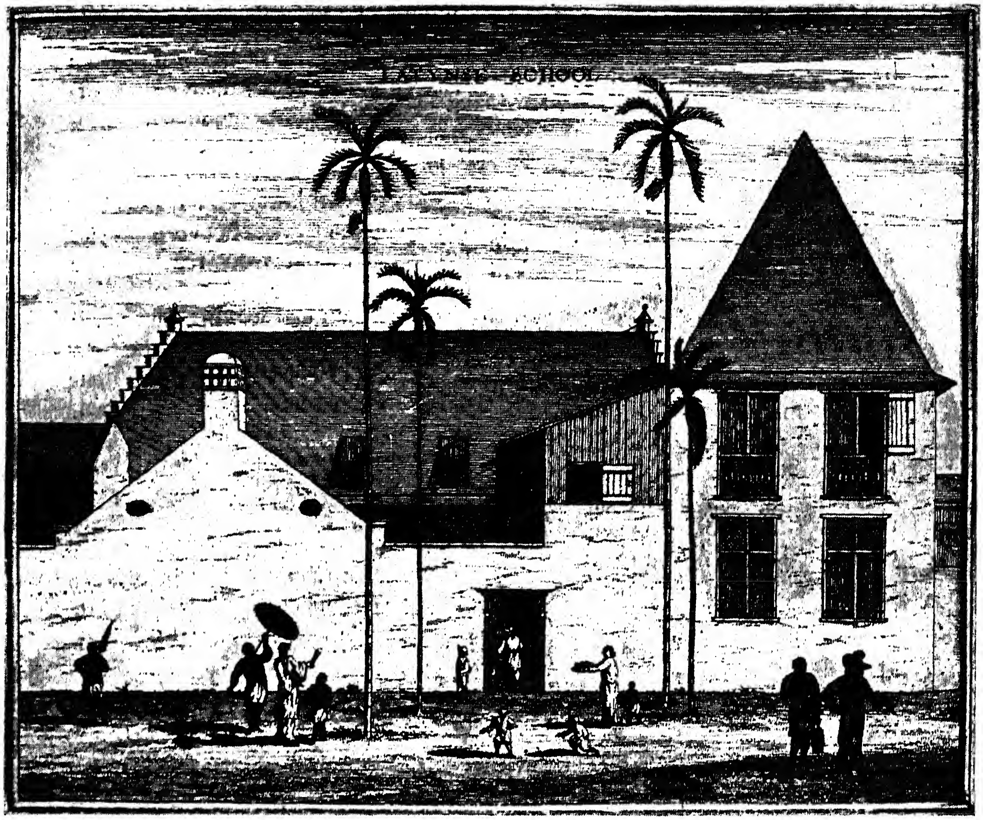

FIGURE 6. — LATIN SCHOOL IN BATAVIA IN THE SEVENTEENTH CENTURY (from JOHAN NIEUHOF'S "Zee en Lantreize," 1682).

# LIST *of* CONTRIBUTORS


'T AMSTERDAM, Gedrukt by FRANCOIS HALMA Boekverkoper 1705.

GURE 7. — FRONTISPIECE OF RUMPHIUS' "D'Amboinsche Rariteitkamer . . . 1705".

# ON LIVESTOCK AND THE VETERINARY SERVICE IN THE NETHERLANDS INDIES

*by*

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According to the Annual Report of the Netherlands Indies Veterinary Service, the livestock at the end of 1937 consisted of: 671,362 horses, 4,413,606 oxen, and 3,197,354 buffaloes — in all 8,282,322 animals.

This total of over eight and a quarter million does not convey much, for in order to obtain a correct view of a country's actual wealth in this respect it is necessary to take into consideration the extent of its area and the density of its population. It would therefore be wrong to conclude from this number that the Dutch East Indies are richer in cattle than, for example, the mother country, because the latter's stock comprises only about two and a half million head. To ascertain the relative wealth in livestock we must calculate separately the number of animals per sq. km. for each of these countries, and then we shall see that in Holland there is an average of seventy head per sq. km. and in the Netherlands Indies 4.3.

Seventy-five per cent of the livestock in the Netherlands Indies is found in Java, Madura, Bali and Lombok, where the relative density is 43 head per sq. km., which means that these places are not far behind Germany, Uruguay, Great Britain and Ireland. The Netherlands East Indies as a whole can in this respect be likened to Brazil and Japan, but they are far behind Holland.

Comparing livestock figures with the number of inhabitants, the Netherlands Indies show that for every one hundred inhabitants there are seventeen head of cattle, but notwithstanding the greater wealth of cattle in Java, Madura, Bali and Lombok, this figure increases to only 17.4 for these places on account of their greater population density. In the Netherlands this figure is 33.25. According to this calculation the Netherlands Indies equals Italy. It compares favourably with China and Japan, but is in a position inferior to that of other Asiatic countries, such as Siam, India and Ceylon. It may be said that as a rule the number of animals per sq. km. increases in proportion to the density of population. In the Dutch East Indies this is shown by the fact that 75% of the livestock is found in Java, Madura, Bali and Lombok — the most populated parts, while in Sumatra, Celebes, Borneo and the Timor Archipelago, where the population is scarce, there is only 25% of the total stock. Exceptions to the above rule are Japan, with a crowded population and few cattle, and Uruguay, where the opposite is the case.

The value of the stock to the inhabitants cannot easily be reckoned in guilders, as to a native a guilder has a value totally different from that which it has to a Hollander. The cost of maintenance for a native agriculturalist with a wife and two children may be reckoned at twenty-five cents per day, which means that such a household can live for four days on one guilder. Taking the income of a Netherlands farmer with a similar family at twenty-one guilders per week, then one guilder is sufficient to keep him for only a third of a day. Estimating the average value of cattle in the Netherlands Indies at twenty guilders per head, and in the Netherlands at two hundred, we see that the selling price of such an animal in the Indies is sufficient to keep a farmer's family for eighty days, while in the Netherlands the sale price is equal to subsistence for only about sixty-six days. It therefore follows that, although the average price of an ox in money is much lower in the Indies than in the Netherlands, this animal is of relatively greater value there economically. Dr. J. Merkens, Director of the Netherlands Indies Veterinary School at Buitenzorg, uses another standard to compute the worth of animals to the native. He expresses their value in working days, and taking the present price at an average of twenty guilders apiece, this represents for an adult native earning fifteen cents per day no less than one hundred and thirty-three working days.

* Reprinted from the *Bull. of the Colon. Inst. of Amsterdam* 2:193-202 (1939).

Although the application of these and similar computations is, naturally, unstable owing to the fact that the various parts of the equations used may widely vary, independently from the others, with the rise and fall of prices and values, enough has been said to prove that cattle in the Netherlands Indies may be regarded as of considerable value. This is also brought out clearly by the words *rojo koyo*, "basis of prosperity" — an expression much employed by the population of East and Central Java to designate cattle.

As mentioned previously, the livestock is unequally distributed over the Archipelago. In Java and Madura its density increases from West to East, except in the case of buffaloes, which are more numerous in the West. The following table proves this:

| | Horses | Oxen | Buffaloes | Total |
|---|---|---|---|---|
| *West Java*. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 65,212 | 86,069 | 862,052 | 1,013,333 |
| *Central Java*, including Surakarta and Jogjakarta | 67,808 | 952,893 | 782,841 | 1,803,542 |
| *East Java*, including Madura . . . . . . . . . . . . . . . . . | 87,896 | 2,498,144 | 370,878 | 2,956,918 |

If we leave Central and East Java out of consideration, the greater part of the stock of oxen is in Bali, which has 208,301 head of cattle, and Lombok, which has 105,702. Over fifty per cent of the total number of horses is found in the Residency of Timor and in Celebes, while buffaloes are more equally distributed, being most numerous where the population is most dense. The uses to which native cattle are put are many. Horses are employed for riding, driving and carrying (pack horses), and some few are butchered, but, contrary to the European custom, they are practically never used for work on the land. Owing to the increase of motor transport they are much less in request than formerly, although they are still in demand in the more primitive regions. Horse-breeding is mostly carried on in the Timor Archipelago, where the animals are allowed to grow up in a half wild state; numbers of them are purchased by Arab dealers who send them to the big towns in Java where, after being broken in, they are put to the above-mentioned uses. During 1937, 11,683 horses were exported from Timor.

Oxen and buffaloes are mainly employed by the natives for agriculture and transport, and their manure is a valuable asset. About ten per cent are destined for slaughtering purposes. In Lombok, in the Timor Residency and in some other parts of the Islands where the inhabitants have not yet acquired the habit of using the plough, the soil is prepared by chasing buffaloes over the inundated paddy fields (*sawahs*). In regions where *gula mankok* (or "cup sugar," a kind of native Javanese sugar) is manufactured, these large beasts are sometimes employed to turn the sugar cane mills. In more primitive regions, such as Sumbawa, buffaloes are still used as beasts of burden. In Madura and in the Madurese parts of East Java, the popular sport of *kerapan*, bull racing, is cultivated, while in Sumbawa buffalo races are in vogue. Another favourite sport, also of Madurese origin, is *adoean sapi* — bull fighting. As with horse-racing in other parts of the world, betting on a large scale takes place in this connection and prizes of considerable value are awarded. Opinions differ as to the significance of these sports in helping to improve the stock, but on the whole not much importance is attached to this question.

Dairy farming has not yet reached the European standard. Dairy stock is to a great extent in European and Chinese hands and, except here and there, is not intensively exploited. The principal reason for this is that a dairy farming class such as we have in Europe does not exist in the Indies. The owners of cows lack both training and experience, and therefore are not expert as dairy farmers. That the dairy stock is improving, however, both in quantity and quality, can be seen from the fact that within the last twenty years it has increased sixfold, while milk production has risen from about four million litres in 1908 to twenty-six million in 1936. The annual sale value of fresh milk may be estimated at about four million guilders. These figures are small in comparison with those of the Netherlands; but in studying them we must not lose sight of the fact that the native population consumes practically no milk, the sale of which is principally confined to Europeans and, to a lesser degree, to Chinese living in the large towns. A small quantity is used in preparing other dairy products. There is certainly an opportunity here for enlarging the dairy farming industry.

The above description shows the position occupied by livestock in native economy, and we think it may now prove of interest to give the reader some particulars about the Veterinary Service, its personnel and its work.

Veterinarians may be divided into four categories:

*a*. Veterinary surgeons in Government service and their assistants. Considering the expanse of the Netherlands Indies, the staff cannot be called very large. It consists of:

The Head of the civil veterinary service, five Inspectors and thirty-two districts surgeons. As assistants there are fifty-eight Indonesian veterinary surgeons and two hundred and twenty-six cattle overseers.

Government veterinary surgeons are educated professionally in the Netherlands at the Veterinary Department of Utrecht University. The University course lasts five and a half years and has gradually become so comprehensive that specialization is increasingly necessary. These veterinary surgeons are appointed district chiefs; from their number the Inspectors are selected and the Head of the Service is chosen from among the latter.

To this category belong the bacteriologists, who are attached to the Netherlands Indian Veterinary Institute which is situated at Buitenzorg, Java. Their training is the same as that of the Government veterinary surgeons, but in addition they take a special course in bacteriology. Their assistants are Indonesian veterinary surgeons who in time will also become bacteriologists.

Their task consists of making serums and vaccines, and preparations such as tuberculin and

mallein, in order to facilitate the diagnosis of various infectious cattle diseases. Further, they are entrusted with the examination of specimens of diseased substances sent to them, and the testing of various medicines for curing cattle diseases indigenous to the Netherlands Indies.

Indonesian veterinary surgeons study for four years at the Netherlands Indies Veterinary School at Buitenzorg, and after that they are attached to a district veterinary surgeon. The best of them may act as deputy district chiefs. The training of a cattle overseer consists of practice under a Government or native veterinarian, or he may follow an eight months' course at the Veterinary School. His duty is to see that the veterinary rules and regulations are observed, and in general to execute the orders of Government and Indonesian veterinary surgeons.

*b*. Veterinary surgeons employed by the municipal councils, and their assistants, comprising Indonesian veterinary surgeons, overseers, meat inspectors, etc.

The number of these municipal veterinary surgeons is twenty-three, and their work, which is specialized and mostly connected with public hygiene, is done independently, except that administratively they are subject to the municipal council. Larger municipalities employ fully qualified veterinary surgeons with Indonesian veterinarians as assistants. In small towns this service is in the hands of Indonesian veterinary surgeons.

*c*. Veterinary surgeons for the Army — nine in number. They are trained at the Veterinary Department of the University of Utrecht and sent out from the Netherlands as first lieutenants. The Chief of this service holds the rank of Lieut.-Colonel.

*d*. Private veterinary surgeons — usually retired Government veterinary surgeons or Indonesian veterinarians.

There are fourteen of these veterinary surgeons in private practice in the Netherlands Indies. The number is small compared to that of their compeers in the Netherlands, where there are several hundred. The reason for this is that there is no country practice for them in the Indies. Besides being too little acquainted with Western veterinary customs, native farmers have no money to spare to call in an expert to attend their animals. If a native requires practical help to cure a sick beast, he goes to a *dukun* (native healer), who usually proceeds to treat the animal by means of amulets or charms, or by administering herbal extracts. For such assistance the *dukun* receives a very small sum of money or payment in kind in the form of rice, fruit, clothes, and the like. Owing to these primitive conditions private veterinary surgeons are found only in the big towns, where they make a living by treating domestic animals belonging to Europeans, Chinese and wealthy natives. On the east coast of Sumatra some of the large plantations have their own veterinarians to take care of the livestock, which they keep on the estates.

The Staff of the Veterinary Institute already mentioned consists of a Director, three bacteriologists, four Indonesian veterinary surgeons, and various other employees. The Veterinary School has a Director, three instructors, two assistant instructors (Indonesian veterinarians) besides other employees.

The veterinary service's work comprises combating infectious cattle diseases and rabies amongst dogs, cats and monkeys; preventing the spread of these diseases by animals transported overseas (quarantine, isolation and similar measures); improvement of cattle and poultry breeding; hygiene; scientific research; preparation of serums and vaccines; the training of native surgeons and other persons connected with the Service. Originally the latter was centralized, which meant that veterinary surgeons worked under an Inspector who was the head of, on an average, seven of them. The Inspector himself was subordinate to the Chief of the Service who, subject to the authority of the Director of Economic Affairs, was entrusted with the general direction. Administratively the veterinary surgeons were responsible to the Resident under whose jurisdiction they worked.

When, in the Government reorganization of 1928–30, the Provinces of West, East and Central Java were brought into existence, together with provincial and district councils, the connection between the Central Department and the Inspectors became looser. These latter were given the title of Chief of the provincial veterinary service and each assigned a Province; the veterinary surgeons, bearing the title of provincial or district veterinary surgeons while in office in the Province, were given charge of districts. Their salaries and expenses were now paid by the Province.

The Province of East Java was divided into seven districts, Central Java into six, and West Java into five. Each veterinary surgeon still had the usual staff of assistants. On account of this reorganization part of the Government's veterinary task was decentralized and transferred to these autonomous authorities. This part comprised local cattle breeding, hygiene and training of overseers and meat inspectors. A share of the activities in combating cattle diseases was also transferred to the provincial authorities.

The part of the Government's duty not transferred was that referring to measures relating to more than one autonomous region. For instance, cattle breeding in general; animal hygiene; prevention of infectious diseases and the spread thereof by animals transported overseas; education of Indonesian veterinary surgeons and others connected with the work; preparation of serums and vaccines, and scientific research at the Veterinary Institute. This combined method of working, whereby the Central Department deals with general questions and the provinces, districts and municipalities are entrusted with the local application of these measures, is satisfactory. For instance, with regard to cattle raising, provinces and districts have an opportunity of buying suitable stock for breeding purposes, establishing cattle unions and funds, and making rules and regulations likely to prove beneficial locally. It stands to reason that provincial and district bodies acquainted with local usage and customs are better able than the Central Department to judge which breeds of cattle are most in demand with the population, where such breeds, when purchased, can be placed to the best advantage, and the special conditions under which the animals should be put at the breeder's disposal and looked after generally.

As mentioned above, general decisions as to cattle rearing and breeding remain with the Central Department authorities, who have the

power to regulate the import of pedigree cattle from countries outside the Netherlands Indies and to determine how such animals shall be disposed of. This prevents the Inspectors from acting on their own initiative and making proposals to their provincial governments about the import and introduction of breeds which might disturb previous, long-established breeding methods, and thus break the much-valued uniformity obtained by continual crossing with special breeds. When, however, as a result of consultations between the Central and autonomous authorities, a special breed for the improvement of the livestock is once chosen, then the local bodies are free to act independently.

The Central Department deals not only with the import and distribution of foreign breeding stock, but also with the placing of such animals indigenous to the Netherlands Indies. For instance, there is the well-known depot on the island of Sumba, whence comes a great part of the country's breeding stock, the *ongole* cattle. The amount of stock available there and the fact that more than one autonomous region has to be supplied must be taken into account, and therefore applications for these animals are always dealt with by the Central Department.

With regard to animal hygiene, local duties consist of making regulations; establishing slaughter-houses; supervising the inspection of milk and meat; inspection of dairies, and meat stalls, establishments for the hire of carts and carriages, and piggeries. This work has been transferred to the municipal and regency councils. The provincial administrations are not directly responsible for the activities but in cases where smaller councils have no veterinary help, the provincial authorities may instruct their experts to perform such local tasks on payment of a certain fee.

The Central Department takes the lead with regard to veterinary hygiene too, but this merely means that the general regulations made by Government ordinance must be observed by the local authorities when making their own regulations. Animal hygiene is more decentralized than cattle breeding.

The training of persons below the rank of Government veterinary surgeon is another of the Central Department's duties which have been partly decentralized. Training of Indonesian veterinary surgeons remains with the Veterinary School, and although it is the local authorities' business to see to the training of cattle overseers and inspectors of cattle and meat, the latter can also be educated at the school, which is naturally preferable, as this institution was established for this particular purpose and has special teachers.

The task of combating cattle diseases, which comprises, of course, the making of local regulations for that purpose, has also been transferred to the local districts. For instance, the province of East Java has a regulation for optional preventive measures against tuberculosis in milch cows. As such regulations very often involve questions of far-reaching intervention in native affairs, they can be enforced only after approval by the Governor-General. Local funds provide money for indemnity payments for animals that have to be killed, for curative medicines and prophylactics against various infectious cattle diseases, and also for combating rabies.

General regulations for the prevention of cattle diseases are made by the Central authorities. These are promulgated by ordinance, Government decrees or by decisions of the Director of Economics.

There has been no question of transferring authority to local governments regarding the prevention of infectious cattle diseases and rabies amongst dogs, cats and monkeys by such animals being transported overseas. This power has been reserved by the Central Service because of its access to the most up-to-date information on infectious cattle diseases in foreign countries and its knowledge of the dangers involved in the import of animals therefrom. These quarantine regulations might interfere with international trade and shipping interests, and therefore it stands to reason that the execution of such regulations cannot be transferred to the autonomous regions.

Finally, decentralization has not been limited to Java and Madura, but in 1937 was also introduced in the Outer Provinces. On July 1st, 1938, two group communities were established, one in Minangkabau on the west coast of Sumatra and the other in Bandjar, comprising the South and Eastern Division of Borneo. In both of these, as in the Java Provinces, government and Indonesian veterinary surgeons, under the supervision of an Inspector, are placed at the disposal of the authorities administering the government in these areas. The Government intends to increase the number of this kind of administrative unit.

# ON THE MINERAL RESOURCES OF THE NETHERLANDS INDIES AND THEIR INDUSTRIAL POSSIBILITIES

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In times of great economic and industrial changes, it is necessary to consider the natural causes that underly innovations.

The Netherlands East Indies find themselves in a situation that necessitates their obtaining from other countries a large number of industrial products formerly imported from Europe. Naturally, this need raises the question: To what extent is it possible to provide at least a few of these products by the development of home industries?

This question, raised after the last war,[1] now, under new circumstances, presents itself with increased urgency.

The desirability — in fact, the necessity — of a gradual industrialization of Java particularly is, therefore, generally admitted.

valued at 362,865,000 guilders; the islands of the Netherlands Archipelago (exclusive of Java) 977,816 tons valued at 166,008,000 guilders, making a total of 2,124,227 tons valued at 528,-873,000 guilders.

These imports fall into two categories:—

I. **Commodities mainly of organic origin** (animals and plants, food and table luxuries, animal and vegetable products, wood, cork, weaving material, furniture, hides, leather and leather products, yarns and dry goods, cordage, paper, and articles made of paper, etc.).

II. **Commodities mainly of mineral origin** (minerals, chemical products, china and porcelain, glass and articles made of glass, metal of every variety, carriages, vehicles, ships, instruments, apparatus, tools).

A light industry, manufacturing articles of the first group, can surely be developed in the Netherlands East Indies. However, the supplying of raw materials for these products is chiefly an agrarian problem and therefore requires no further consideration at this point.

| Import of Group II in 1939 | Weight in Tons | | Value in Guilders | |
|---|---|---|---|---|
| | Java and Madoera | Outer Possessions | Java and Madoera | Outer Possessions |
| Minerals | 253,964 | 195,125 | 6,503,000 | 6,131,000 |
| Chemical products etc. | 181,798 | 69,692 | 37,925,000 | 11,517,000 |
| Ceramic and porcelain | 23,780 | 14,184 | 2,490,000 | 1,281,000 |
| Glass and articles made from glass | 17,700 | 5,650 | 3,590,000 | 1,201,000 |
| Metals but not gold and silver | 177,050 | 131,419 | 32,973,000 | 26,221,000 |
| Vehicles, carriages, craft | 15,868 | 5,989 | 28,557,000 | 4,645,000 |
| Machines, implements, appliances, tools | 30,503 | 27,155 | 37,828,000 | 23,529,000 |
| Total | 700,666 | 449,214 | 149,866,000 | 74,525,000 |
| General total | 1,149,880 | | 224,391,000 | |

The question of the extent to which importation can be replaced by home production raises a comprehensive problem in which, besides technical matters, economic, social, and political considerations have a part. In the following pages, certain aspects of the question, especially those connected with the providing of minerals, will be discussed.

Statistics show that importations into the Netherlands East Indies during 1939 were as follows: Java and Madoera, 1,146,411 tons

In 1939, the importation of articles of the second group was as follows: 1,149,880 tons or 54.1 per cent of the total weight, valued at 224,-391,000 guilders or 42.3 per cent of the total value of all imports, as shown in the above table.

Domestic mineral raw materials have a very

* Based on the author's "Delfstoffen van Nederlandsch Indië als Grondstoffen der inheemsche Industrie" (Natuurwet. Tijdschrift voor Ned. Indië 101:11–19, 1941). — Grateful acknowledgment is made of the assistance rendered by Dr. J. MAAS (Board for the Netherlands Indies, Surinam and Curaçao) in making this account ready for press.

[1] The plans which were worked out during and shortly following the First World War and which have to some extent materialized include the following: the exploitation of water power in the Outer Possessions for a nitrogen plant (Assahan River in Sumatra and Mamasa River in Celebes), the manufacturing of glass (Sumatra's east coast), the cement industry in Java (Proepoek, Tjibadak), ceramics (Kediri, Malang), acetic acid factory (Tjilatjap), iodine factory (Gedangan), asphalt industry of the municipality of Cheribon at Palimanan (Cheribon), India rubber factory (Bandoeng), Insulinde oil factories, factory for railroad material (Cheribon), blast furnaces (Lampongs), cannery (Bandoeng), a number of factories for building materials, and a factory for making fireproof brick, N.I.C.K.I. (Rembang).

Most of these plans did not materialize or the industries failed during the crisis of 1921–1923.

In many instances, one of the main reasons for these failures was the lack of sufficient preparatory study to determine the actual presence of raw material, the quantity in which it was present, and its usefulness for industrial purposes. From these experiences of twenty years ago, the lesson to be learned is this: before everything else, study the available quantity, quality, and position of the raw material.

significant connection with the plans to develop industries producing articles belonging to the second group.

To this category belong: —

1. Processing of petroleum, coal, and ore,
2. Metal and machine industry,
3. Chemical industry,
4. Ceramic industry,
5. Building material industry.

**Processing of Petroleum, Coal, and Ore:** — The most important processing of indigenous material is the manufacture from Netherlands Indies petroleum in the refineries of the large oil companies of dozens of products for immediate use. These industries are known as "Overseas plants" because their perfecting resulted from the use of overseas science and technique.

Coal mined in the Netherlands East Indies is prepared for the market by the simple process of washing. Processing of coal dust into briquettes is done at Tandjok Priok.[2]

Netherlands Indies coal cannot — or only with difficulty can be — made into coke. Therefore, it cannot easily be used as a basic material for chemical and metallurgic industries.[3]

However, it is not impossible that the excessively large quantities of inferior coal and lignite found in the Netherlands East Indies (Sumatra and East Borneo) may still be used as raw material for such industries (oil derived from coal, for instance).

In thinking of supplying power for industry, one should note the possibility of using volcanic energy. Witness the steamdrilling operations at Kawah Kamodjan to supply motive power for low-pressure turbines.

Tin is the most important ore produced in the Netherlands East Indies. In 1937, the Netherlands East Indies mined 39,760 tons of tin, almost 18 per cent of the world's production for that year. This metal is used very little in the country itself; therefore, it is mainly an article of export. Bangka ore is smelted into tin on Bangka; charcoal is used in the process. Billiton ore — until the invasion of Holland — was smelted, for the most part, at Arnhem; since the invasion, this has been done in Malakka.

The bauxite ore of Bintan is still the most important raw material for the Japanese aluminum industry. In 1939, its production amounted to more than 230,000 tons. The plans of the Billiton Company — already far advanced — to erect a factory for aluminum oxide ($Al_2O_3$) and another for electrometallurgic aluminum on the Assahan River in order to use the energy of the Assahan waterfalls had to be abandoned because of the war. However, the foundations of this industry seem to be sound; it is expected that the delay is only temporary. The metal to be produced will be used for manufacturing articles for the home market in a factory near Djokja. Five thousand tons a year — production and sale — seems to be the minimum requirement for the success of the undertaking.

Although the quantity of bauxite reserves thus far discovered is small compared with the world reserves (circa 20 million tons and 1000 million tons respectively), it may be considered sufficient to maintain the present production for some decades.

The nickel ore of Middle and Southeast Celebes may possibly be concentrated in the future at the mine itself into less voluminous products, according to the Stürzelberg or Renn-process. The total nickel ore reserves of the Netherlands East Indies thus far discovered are still small, somewhat in excess of a million tons of ore with an average of not quite two per cent of Ni. The quantity of nickel metal which might be produced from this ore would amount to scarcely one-sixth of the entire production of the world in one year (117,000 tons in 1937). The possibilities of other nickel ore deposits, however, are now being investigated.

In 1939, the nickel ore production amounted to only 23,535 tons, but it increased rapidly in 1940.

In addition to nickel ore, manganese ore is now found in the Netherlands East Indies (12,074 tons in 1939). Gold and silver ore are also present (2,525 and 19,222 kilograms respectively in 1939). The manganese reserves at present known are small,[4] as are the better known gold and silver reserves.

Finally, the Netherlands Indies reserves of iron ore should be mentioned. A couple of hundred million tons of the lateritic type with a content of 40 to 50 per cent of iron ore are here available.

Extensive plans for the processing of domestic iron ore were worked out for Celebes and southeast Borneo after the last world war (note Reports and Communications concerning Netherland Indies Minerals and their Use Nos. 7, 8, 9, and 15), but they were never carried out.

One of the chief difficulties was the dependence upon the importation of coke, for Netherlands Indies coal cannot be made into coke. It is possible that, in the future, through new processes to be developed (such as the Stürzelberg or the Renn-process, which use rotating ovens and are able to use inferior coal), ore may be melted at the mine, or at least processed into semi-manufactured material (*i.e.* puddle, and sponge iron).

New attention is being given the titanium iron ore of Java. Plans have been laid out for manufacturing cast steel on a small scale; titanium oxyde could be a by-product, partly to take the place of lead and zinc white.

**Metal and Machine Industry:** — The possibility that the Netherlands East Indies will be able to find in its own soil enough ore to supply a metal and machine industry is true principally for tin, aluminum, and perhaps iron and nickel. Copper, lead, and zinc ores are found in these regions in only small quantities. Nor are the reserves of steel-improving metals, such as manganese, chromium, wolfram, and molybdenum of great importance. Moreover, the metallurgy of steels and other alloys is a very specialized science which demands an extensive professional knowledge and thorough preparation. Perhaps, in the future, it may be possible to manufacture certain iron alloys (with manganese, chromium, nickel, and others) on a modest scale in the Netherlands East Indies, but the metal and machine industries in that country will have to depend mainly upon the importation of various

[2] In 1939, the coal import of the Netherlands East Indies was 69,801 tons worth 1,055,319 guilders.

[3] In 1939, the coke import of the Netherlands East Indies was 5.462 tons valued at 191.214 guilders.

[4] Further explorations of the manganese ore reserves are now being conducted.

metals and metal alloys. Whether or not such industries will have a chance to develop will depend chiefly upon the availability of inexpensive energy (coal, fuel oil, water power, and others), cheap and well trained laborers, and adequate home markets.

**The Chemical Industry:** — The chemical industry in the Netherlands East Indies will, in the beginning, have to concentrate also on those products for which there is a local market.

In 1939, some of the chemical products imported were the following: 1,834 tons of sulphur valued at 158,516 guilders, 3,898 tons of alum at 286,190 guilders, 20,884 tons of calcinated and caustic sodium at 2,130,211 guilders, 1,565 tons of raw and refined sulphuric acid at 145,235 guilders, 320 tons of acetic acid at 72,241 guilders, and 1,235 tons of formic acid at 392,098 guilders.

It might be possible to subject a number of chemical products to a process of total or partial refining. For instance, the mother liquid of the solar evaporation ponds could be further concentrated in pans heated by steam. By this method, not only household salt and gypsum can be manufactured, but Glauber's salt ($Na_2SO_4 \cdot 10H_2O$), magnesium sulphate ($MgSO_4 \cdot 7\,H_2O$), magnesium chloride and potassium chloride.

Glaüber's salt might be used in glass factories; and, for potassium chloride, products of the domestic chemical industry might be substituted.

A chemical industry in this country, however, will have to recognize that, while large sums of money will be needed to start the basic industries (sulphuric acid, sodium, ammonia, and so on), the sales-possibilities of its products and by-products in the local market will be small.

The importation of fertilizer (potassium, superphosphate, sulphate of ammonia, etc.) is very important to the agriculture of the Dutch East Indies.

A result of the investigations of the last ten years into the possible presence of natural phosphate in Java is the conclusion that the island has a reserve of about 500,000 tons of calcium phosphate and 100-150,000 tons of aluminum phosphate. This will make it possible to supply from local sources the greater part of the phosphate now being imported, for a period of at least fifteen to twenty years (see the above table).

Plans have already been made to extract potassium from molasses, which owes its richness in potassium to the great potassium content of the soil in which the sugar cane grows. This potassium can be used later as fertilizer for soils deficient in potassium. Potassium made in this way may also be used for the manufacture of glass. The husks of kapok and coconut, usually thrown away, can likewise be used for the manufacture of potassium.

The sulphur of the Kawah Poetih or other E. Indies volcanoes can serve as raw material for the manufacture of sulphuric acid.[5] This sulphuric acid may be used for making fertilizers, like ammonium sulphate, and for the manufacture of alum and aluminum sulphate.

Plans for building an ammonium sulphate factory with a capacity of 40 to 45,000 tons a year at Tjepoe are well under way.

Moreover, sulphuric acid may be used for the manufacture of hydrochloric acid from Madoera household salt. Glauber's salt is a by-product which may be used in glass factories.

Likewise, experiments might be made in extracting leucite ($KAlSi_2O_6$) from rock formations — like those found in Moeriah and the Ringgit in Java — rich in potassium in order to use the mineral as a basic material in the preparation of potassium fertilizer.

The construction of large water works, like those already built on the Assahan for the manufacture of aluminum, makes it possible to supply power simultaneously to several industries in need of inexpensive electrical energy (*i.e.*, manufacturing of cyanamid, electrolysis of household salt for the preparation of sodium hydroxide).

The manufacturing of ammonia in the Netherlands East Indies might develop into an important key industry through which a number of other, domestically marketable chemicals, such as ammonium sulphate, ammonium phosphate, ammonium chloride, and ammonium nitrate, could be produced.

Ammonium can be made by leading steam over cyanamid, and also according to the Haber-Bosch process. For the latter coke, which must be imported, is needed.

Caustic soda, for which there is great demand by the local soap manufacturers, can be made by

| Import of Fertilizer in 1939 | Weight in Kilograms | | Value in Guilders | |
|---|---|---|---|---|
| | Java and Madoera | Outer Possessions | Java and Madoera | Outer Possessions |
| Chili salpetre | 547,100 | 13,067 | 33,025 | 805 |
| Guano | 626,957 | 402,606 | 53,558 | 35,320 |
| Potassium fertilizer | 3,213,508 | 3,771,546 | 213,298 | 289,634 |
| Superphosphate and double superphosphate | 3,957,156 | 518,107 | 287,978 | 30,931 |
| Sulphate of ammonia | 86,948,721 | 11,836,808 | 5,573,880 | 759,118 |
| Fertilizers n.o.s. | 24,282,580 | 19,005,356 | 2,192,616 | 1,036,191 |
| Total | 119,576,022 | 35,547,490 | 8,354,355 | 2,151,999 |
| General total | 155,123,512 | | 10,506,354 | |

[5] It is necessary to point out in connection with this fact that the known reserves of rich sulphur deposits are rather small (somewhat in excess of one million tons with a content of 50 to 60 per cent sulphur. Note Reports and Communications etc. Nos. 1, 17, and 22.) However, when the supply of sulphuric mud of low sulphur content is taken into account, the quantity of sulphur which can be found in this country is considerably larger. According to tests now being made in Java, it is still possible to concentrate sulphuric mud with a content of 20-25 per cent sulphur and get satisfactory results. The sulphur of the Kawah Poetih factory is already being used by the sulphuric acid factories for the oil refineries in the Netherlands East Indies.

combining sodium carbonate with calcium hydroxide.

Moreover, it is possible to find in the Netherlands East Indies the raw material for the small chemical industries — material like the deposit of iron-ochre and calcium iron-alum which are formed in the mineral springs near Tjiater on the northern slope of the Tangkoeban Prahoe.

In our review, we must limit ourselves to indicating certain possibilities. Most of the minerals for a chemical industry are present in the Netherlands East Indies. To what extent such an industry can actually be built up in that country is determined by other factors, such as calculations concerning productivity, the desirability of making oneself independent of foreign producers, and so on. To avoid disappointment and to understand thoroughly the technical and economic demands that will be made upon the industries to be founded, it will be necessary to postpone the carrying out of plans until an exhaustive study of the quality, quantity, and accessibility of the mineral materials in relation to their present position has been concluded.

PRODUCTION OF MINERALS IN THE NETHERLANDS EAST INDIES IN 1937, 1938, AND 1939: —

| | UNIT | 1937 | 1938 | 1939 |
|---|---|---|---|---|
| *A. Organic Minerals* | | | | |
| 1. Petroleum | kgt | 7,262,000 | 7,398,150 | 7,948,700 |
| 2. Natural gas | $m^3$ | 1,141,000 | 1,227,600 | 1,263,250 |
| 3. Coal | kgt | 1,363,600 | 1,456,650 | 1,780,650 |
| 4. Asphalt limestone | " | 2,200 | 6,220 | 5,380 |
| *B. Ore* | | | | |
| 5. Tin | kgt | 39,760 | 27,734 | 28,200 |
| 6. Gold | kg | 1,730 | 2,378 | 2,525 |
| 7. Silver | " | 15,555 | 18,018 | 19,223 |
| 8. Bauxite | kgt | 198,970 | 245,350 | 230,670 |
| 9. Nickel ore | " | — | 20,000 | 23,535 |
| 10. Manganese ore | " | 11,080 | 9,690 | 12,070 |
| 11. Monazite sand | " | 370 | 393 | 123 |
| 12. Copper | " | 49 | 93 | 94 |
| 13. Lead ore | " | — | 50 | 60 |
| 14. Platinum | kg | — | 0.65 | 0.9 |
| 15. Wolframite | kgt | 0.4 | 0.4 | 3.5 |
| *C. Non-Metallic, anorganic minerals* | | | | |
| 16. Phosphate | kgt | 26,170 | 33,110 | 18,780 |
| 17. Sulphur products | " | 12,670 | 16,240 | 17,570 |
| 18. Iodine compounds | " | 116 | 62 | 37 |
| 19. Limestone | " | 424,680 | 608,470 | 639,880 |
| 20. Kaolin | " | 780 | 2,700 | 2,810 |
| 21. Trass | " | 1,430 | 1,650 | 1,900 |
| 22. Lime | " | 19,420 | 31,780 | 31,770 |
| 23. Diamond | carat | 957 | 1,579 | 2,287 |

**Ceramic Industry:** — The raw materials necessary for ceramics are undoubtedly present in sufficient quantity in the Netherlands East Indies to take care of most of the home needs; in 1939 this called for an import valued at 8,562,000 guilders.

Some small and some large manufacturers have already started the industry through the making of glass and pottery on a small scale; it is effectively supported by the ceramic laboratory of the Department of Economic Affairs at Bandoeng.

The essential basic materials for glass are quartz-sand (for the silic acid) and certain additional secondary materials such as soda, Glauber's salt, and other minerals containing sodium (to supply $Na_2O$), potassium, and potash-feldspar (supplying $K_2O$), limestone (supplying $CaO$), and red lead (supplying $PbO$). Other essentials are smelting-accelerators (borax, fluorspar, and potassium nitrate), means of refining, discoloring and coloring matter, and other special by-products. According to DAVIS,[6] the quartz-sands present in the Netherlands East Indies can be used for the manufacturing of half white glass and white glass, but the manufacturing of crystal or half crystal from quartz-sand now known to exist in the Netherlands East Indies must be considered impossible.

A glass factory, which will use as raw material, for the manufacture of cheap and coarse glass containers for chemicals, the dune sand found in the region, is to be built near Toeban. Moreover, it is planned to produce ten million beer bottles yearly; this will take care of two-thirds of the home need.

Different kinds of native clay are available for the making of pottery. But, in connection with this undertaking, besides a technical research into the quality of the material, a geological survey into the available quantity should be made.

Porcelain clay (kaolin) is found in large quantities, particularly in Bangka and Billiton.

**Building Materials:** — Industries for the manufacture of building materials — cement, trass, lime and limestone, brick, and tiles, and so on — have been established in the Netherlands East Indies for a long time. They depend mainly upon local raw materials, and are always dependent upon home market possibilities.

Expansion of the cement manufacturing is still possible, as is seen in the fact that in 1939, the Netherlands East Indies imported 161,369 tons of Portland cement valued at 2,098,000 guilders.

Thus far too little attention has been paid to the home production of natural stone for storefronts, doorsteps, office buildings, and so on.

**Export:** — It is evident from this statement that the Netherlands East Indies produce only a small amount of minerals. The only trump-

[6] *Ingenieur in Nederl.-Indië*, 6, No. 5, May 1939, Part I.

cards on the world market are petroleum and tin, while bauxite and nickel-ore are significant, especially with respect to the mineral deposit conditions in East Asia.[7]

Countries with a large domestic production and reserve of minerals, particularly coal, coke, and iron ore, occupy a stronger position in the industrial competitive struggle than countries like the Netherlands East Indies, which have to import most of the raw material for their heavy industries. Apart from the possibility of establishing certain industries devoted to metal manufacturing, metal processing, and the building of machinery to care for local and regional needs, it cannot be expected that a territory like the Netherlands East Indies will have a chance to develop an important heavy industry dependent partly on export.

As far as the chemical industry is concerned, possibilities for further development do exist, because the Netherlands East Indies import various chemicals (sulphur, alum, gypsum, sodium, potassium fertilizer, superphosphates, ammonium sulphate, and other synthetic fertilizers) in rather large quantities, even though the basic material for the possible manufacture of a number of these chemicals is actually present.

Likewise, the ceramic, glass, and building materials industries may be further developed with the help of home raw materials.

It is, however, necessary to establish an efficient coordination between the advisory bodies and those interested in a general way.

Care should be taken that the same mistakes made in the period during and immediately following the world war of 1914–1918 are not repeated. Then a number of industries were started with a certain lack of insight into the quality, quantity, and position of the necessary mineral raw materials. Hence the disastrous results mentioned in the beginning (*Note 1*).

The Department of Mining, particularly the former Exploration Department and the present Geology Department, as well as the private mining companies, have tried for several decades to trace the minerals of the Netherlands East Indies, to test them, and to take stock of them. Until about 1930 these activities were concerned chiefly with petroleum, coal, and ore. After that, the anorganic, non-metallic raw materials were examined, first incidentally, but for the past few years more systematically. Through the publication of the Reports and Communications concerning Netherlands Indies Minerals and their Applications No. 22 (Minerals in Java, except petroleum, coal, and ore), a beginning of the systematic stock-taking of this group of minerals was made.

The following minerals were dealt with: natural gas, alum, alumite, barite or heavy spar, diatomaceous earth, phosphate, gabbro, serpentine, gypsum, granite or diorite, etc., resin (fossil), iodine, rock formation containing potassium, limestone, kaolin, carbonate, quartz-sand and quartz sandstone, marble, obsidianite, ochre, oil shales (with ichthyol-like components), pumistuff, trass, Fuller's earth, and sulphur. In this publication many suggestions concerning the possible use of these minerals were mentioned. Those who wish to execute certain plans in this field should formulate their plans and thus lead to a more precise definition of the requirements regarding quality, quantity, position, price, and so on, as a guide for further exploitations.

Reliable suggestions regarding the possibilities of the East Indies soil's producing minerals of value for industry are possible only when stock of all available minerals has been taken. Such a survey can be made only through a systematic geological exploration of these regions — a work which will demand many years of scientific study. Undoubtedly, the Department of Mining has already done a great deal of good work in this respect. The efforts of the former Department of Exploration were focussed primarily upon finding certain minerals, such as petroleum, coal, and ore, suitable for export and not particularly upon producing goods for home use, because formerly market possibilities were exceedingly limited.

In this respect, a great change has recently taken place. That is why many minerals and non-metallic minerals to which no attention was formerly paid may now be considered for production. The older reports of the Geological Mining explorations of large territories in the Netherlands East Indies give little or no data about minerals which, on account of changed conditions, became or will become important. We are thinking, for instance, of bauxite, of raw material for the chemical, ceramic, and glass industries, of building materials, and so on. It is not at all impossible that industrial raw materials will be found in Java and the Outer Possessions; they may supply the necessary and much-desired foundations for the development of the industrial process.

A distinction may be made in this connection between:—

1. minerals significant for military defence, for the production of which financial considerations are of minor importance, and

2. minerals which, as basic material for industry, are important for the economic defence of the Netherlands East Indies.

Let us consider the first category. Because of urgency, the Geological Service might even now express its opinion concerning the possibility of home production with the aid of available geological mining data, supplemented by investigations of short duration of the known sources.

The registration and listing of the second group of minerals is also urgent. It can be accomplished only with the aid of systematic geological maps. In order to attain practical results with map making, it is possible, guided by geological insight, to investigate first those territories where certain minerals can be expected. Furthermore, the interest of the population for certain minerals may be aroused and private initiative enlisted in the detailed search for certain possibilities.

Through the making of systematic geological maps, the focussing of too much attention on the finding of specific minerals, as distinguished from minerals in general, will be prevented. For this reason, in times such as these, when the demands for mineral raw material for home industry are growing, the progress of systematic mapping which takes many years to complete should not be neglected. In the first place, a modern geological map of Java, the nerve centre of the Netherla[illegible]

[7] In connection with this statement, compare R. W. VAN BEMMELEN:
"The Division of Minerals over the Earth as a Factor in World Economy," published in the *Economisch Weekblad* of October 18 and 25, 1940, and in the *Koloniale Studiën* No. 5, 1940, as well as "The Mineral Position of East Asia (particularly that of Japan)" *Economisch Weekblad* No. 46, Nov. 15, 1940.

East Indies, should be made because Java will probably be, in the near future, the first part of the Indies to undergo the process of industrialization.

Before finishing this short discussion concerning the industrial minerals of the Netherlands East Indies, one more general remark should be made. It is essential that the scientists in these territories should coöperate in helping the Netherlands East Indies through this difficult phase of its existence so that a stronger country shall grow up, less dependent upon foreign markets. These islands will then possess new reserves of strength which can be made available for the rise and rebuilding of its mother country.

# LE JARDIN BOTANIQUE DE BUITENZORG ET LES INSTITUTIONS DE BOTANIQUE APPLIQUÉE AUX INDES NÉERLANDAISES

*par*

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Monsieur le Président, Mesdames et Messieurs,

Je vous remercie d'avoir bien voulu me confier la tâche de parler à votre grande séance annuelle. J'ai choisi un sujet qui, je l'espère, vous intéressera; il me tient à cœur, parce qu'il a été pendant presque 30 années le centre de mon activité et que j'ai aimé le pays dont je vous entretiendrai, que j'ai admiré les institutions qui en ont fait la grandeur, les hommes qui ont, dans ces régions lointaines, travaillé avec acharnement pour faire œuvre utile.

Je voudrais pourtant, en commençant, rappeler le souvenir de mon vénéré et regretté maître ROBERT CHODAT et placer cette conférence sous son égide, dans cette salle où si souvent je l'ai entendu donner ses précieuses leçons, et au sein de cette Société botanique qu'il avait su rendre si vivante et qu'il a présidée longtemps avec l'autorité et l'enthousiasme dont beaucoup d'entre vous se souviennent. Je vous remercie, M. le Président, de m'avoir donné cette occasion de rendre ici un respectueux hommage à la mémoire de mon cher maître.

J'entre maintenant dans le cœur de mon sujet, sans perdre mon temps à des préambules, car j'ai beaucoup de choses à vous raconter et mon temps est limité: le Jardin botanique de Buitenzorg (*Hortus bogoriensis*, comme on le voit indiqué sur les étiquettes des herbiers), est une institution de réputation mondiale, dont vous avez certainement tous entendu parler, dont vous avez vu de belles photographies, et qui est comme un paradis où tous les botanistes ont rêvé d'entrer un jour pour faire connaissance avec la nature tropicale.

Et ils sont heureusement nombreux dans notre pays, ceux qui, dans les belles années prospères d'autrefois, ont pu réaliser ce rêve, soit en obtenant une bourse de voyage suffisante pour passer quelques mois à Java, soit en s'engageant pour un temps plus ou moins long dans une des institutions scientifiques de ce beau pays.

Vous comprendrez sans peine l'émotion du jeune botaniste qui, frais débarqué, après un long voyage de trois ou quatre semaines, se hâte vers la petite ville de Buitenzorg, enfouie dans de grands arbres, au pied des volcans jumeaux couverts de forêt vierge, le Salak et le Gedeh ... son émotion, quand il arrive dans ce centre scientifique dont, au cours de ses études, il a tant entendu parler! ... son émotion, quand il pénètre dans les larges avenues de ce jardin, comme dans un lieu étrange, dont il peut faire connaissance enfin, autrement que dans des livres ou d'après des images. A certaines heures du jour, quand il entre sous les voûtes sombres des bambous, le long de l'étang où sommeillent les larges feuilles des *Victoria regia*, où se balancent les parasols des Lotus, entre les piliers immenses de l'allée des *Canarium*, dans cette atmosphère humide et chaude à l'odeur si particulière, il vit un peu les impressions de Sindbad le marin, pénétrant enfin dans les jardins fantastiques des contes des Mille et une nuits.

Au cours de son voyage, le botaniste a vu en passant les jardins de Peradeniya, de Singapore et ces beaux parcs, où il s'est promené en rickshaw ou en voiture et qui auront été sa première impression tropicale, restent bien vivants dans son souvenir; peut-être, au premier abord, sera-t-il un peu déçu par le Jardin de Buitenzorg, qui est moins «parc», moins arrangé pour le public; mais, quand il aura constaté l'ordre scientifique qui règne dans les divers quartiers où sont groupées les familles, quand il aura passé quelques heures dans le quartier forestier où sont réunies les plantes du sousbois, quand il aura visité la nouvelle partie du jardin, avec quelques hectares de forêt reconstituée, quand il aura vu ce merveilleux musée vivant que constitue la palmeraie, quand il aura rêvé sous les allées de bambous, de fougères arborescentes, de *Canarium*, de palmiers royaux, quand il aura découvert, blotties dans les herbes la délicate *Thismia* ou une pâle orchidée saprophyte, quand il aura aperçu au pied d'une liane les boules brunes d'une *Rafflesia* et ailleurs l'immense inflorescence d'un *Amorphophallus*, le voile immaculé d'une *Dictyophora* et, le soir, la vague lueur d'une Mycène lumineuse, quand il aura été ainsi d'enchantement en enchantement, alors il comprendra tout le charme de ce monument botanique, il comprendra que tous ceux qui y ont vécu, qui y ont travaillé, qui y ont cherché et trouvé des trésors scientifiques, aient pu lui donner leur admiration et leur reconnaissance

* Conférence donnée à la séance du 18 mai 1936 de la Société Botanique de Genève (Bull. Soc. Bot. Genève 28:77-93).

et aient tout fait pour contribuer, chacun dans son domaine propre, à sa réputation.

Le Jardin Botanique de Buitenzorg, fondé en 1817, fut tout d'abord un beau parc relevant de l'administration de l'Instruction publique; avec son personnel très restreint, il travaillait surtout comme centre de collaboration avec les Instituts scientifiques hollandais; il était le point de départ et d'organisation des expéditions botaniques qui se proposaient d'explorer l'une ou l'autre des régions plus ou moins connues de l'immense domaine de Indes Néerlandaises. Des travaux scientifiques sortaient déjà de Buitenzorg, surtout des contributions à la connaissance de la flore; SCHEFFER avait même publié, en 1876, le premier volume des *Annales du Jardin Botanique de Buitenzorg*, qui devaient devenir par la suite un des plus importants périodiques botaniques, certainement le plus important des périodiques traitant de la botanique tropicale.

Après la mort de SCHEFFER, un jeune botaniste, MELCHIOR TREUB, dont les origines suisses vous sont certainement connues, et qui avait déjà publié d'intéressants mémoires sur divers sujets de botanique générale, fut envoyé à Buitenzorg pour prendre la direction du jardin botanique; il y arriva en 1883 et resta près de 30 ans à la tête de cette institution; on peut dire qu'il l'a recréée dans la forme qu'elle a prise peu à peu et dans le développement qu'elle a acquis par la suite.

Parler de l'œuvre de TREUB, c'est faire l'histoire du Jardin et réciproquement, car l'un ne va pas sans l'autre et l'on peut dire que toute l'activité scientifique et administrative de ce grand savant ont tendu à perfectionner, à organiser sur une base bien déterminée et logique l'Institution qu'il dirigeait et à mettre en pratique les principes qu'il avait fixés à son développement rationnel.

TREUB n'était pas un systématicien et il s'éleva tout d'abord contre l'idée que *son* jardin botanique ne devait être qu'une sorte d'intermédiaire destiné à récolter des plantes et à les envoyer en Hollande pour y être étudiées; il pensait au contraire que ce devait et pouvait devenir un centre de recherches, où l'on poursuivrait sur place, dans des conditions naturelles et normales, l'étude du riche matériel qui serait plus facile à examiner à l'état frais que détérioré par un long séjour dans l'alcool ou entre les feuilles grises du papier d'herbier. TREUB pensait que ce principe devait être vrai non seulement pour l'anatomie et l'embryologie, mais aussi pour la physiologie, et il pressentait le nombre immense des problèmes qui se posent concernant la vie des plantes tropicales et dont les données ne pourraient être réalisées dans un pays tempéré. Pour démontrer la justesse de ses idées, il a prêché d'exemple. Je ne vous donnerai pas la liste détaillée des travaux de TREUB; ils sont connus de la plupart d'entre vous; vous savez que, dès son arrivée à Buitenzorg, il se mit à étudier les problèmes les plus variés et que, depuis 1885, moment où parut le deuxième volume des Annales, il publia dans ce périodique chaque année un ou plusieurs mémoires sur des chapitres importants de la science botanique; non pas seulement de simples notes d'observations, mais des études d'où il pouvait tirer des conclusions venant appuyer telle ou telle théorie générale. Vous connaissez ses recherches morphologiques sur le développement du prothalle des Lycopodes; sur la nature et l'anatomie des lianes; celles sur *Dischidia* et *Myrmecodia* qui ont bouleversé les idées qui avaient cours alors sur la myrmécophilie; ses études sur l'apogamie, la polyembryonie; ses observations basées sur l'embryologie, pour établir la place des Casuarinées et des Burmanniacées dans le système végétal; vous n'ignorez pas qu'il a signalé la présence d'acide cyanhydrique libre dans certaines plantes et qu'il en a tiré des conclusions importantes quant à la théorie de l'assimilation. Travaux toujours originaux, interprétations souvent géniales, conclusions qui sont devenues classiques.

J'ai dit que TREUB n'était pas systématicien; il ne faudrait pas croire cependant qu'il négligeât cette partie de la science botanique, bien au contraire; il savait qu'elle était indispensable à tous les chercheurs, dans quelque domaine qu'ils se soient spécialisés et il déplorait que les collections de Buitenzorg aient été jusqu'alors si mal entretenues; aussi fit-il bien vite installer des locaux appropriés pour les collections de l'herbier; toute une pléiade de systématiciens, fonctionnaires du jardin ou botanistes de passage se mirent à la besogne pour étudier le matériel; plusieurs explorateurs, et le service forestier surtout, contribuèrent à enrichir l'herbier et le musée; des monographies de familles furent publiées, des observations furent notées dans le nouveau périodique, les *Icones bogorienses* et dans le *Bulletin du Jardin botanique*[1]; TREUB lui-même publia une intéressante étude, pleine d'aperçus ingénieux, sur «la forêt équatoriale comme association»; il fit des recherches dont je parlerai plus loin sur la nouvelle flore du Krakatau; il s'intéressa personnellement aux études de plusieurs botanistes sur la mangrove et d'autres formations végétales intéressantes, etc., etc.

On conçoit que, dans ces conditions, si le jardin de Buitenzorg attirait les botanistes par sa situation au centre de la végétation luxuriante des Tropiques, comme aurait pu les attirer tout autre jardin à Ceylan, au Brésil, en Afrique équatoriale, c'est pour le génie de TREUB surtout que de nombreux naturalistes vinrent travailler à Java; ils n'ignoraient pas qu'ils y seraient aidés, pilotés par le grand savant, si bien au courant de toutes les possibilités de travail, de tous les problèmes qui arrêtent à chaque pas les nouveaux venus.

TREUB avait trouvé les services du Jardin botanique plus ou moins bien installés dans les locaux désaffectés d'un ancien hôpital militaire; tout son effort tendit d'abord vers une amélioration des instruments de travail et vers une meilleure organisation de l'administration. Il se fit aménager un bureau convenable et construire une confortable maison dans le jardin, tout contre le mur de verdure d'une allée de Gnetums, cette liane curieuse qui est une énigme pour tous les botanistes quand ils ne la connaissent que par les livres. Il organisa mieux la répartition des plantes dans le jardin et fit augmenter le nombre des individus cultivés, provenant de toutes les parties de l'Archipel; il créa des laboratoires commodes (jamais luxueux) pour les services entomologiques, pour l'étude du riz et du café, pour la chimie végétale, la pharmacologie, etc.

Enfin, placé devant la multiplicité des problèmes scientifiques qui se posaient, il comprit qu'il ne pouvait les résoudre seul ou avec l'aide de quelques collaborateurs et il entreprit de faire école,

[1] Plus tard, dans un nouveau périodique *Treubia* furent consignées les observations faites aux Indes-Néerlandaises et dans le domaine de la zoologie.

d'amener à lui des savants de tous les pays, de mettre à leur disposition des locaux bien aménagés; il fonda donc cet Institut qu'il nomma le Laboratoire des Etrangers et qui, reconstruit il y a quelques années, s'appelle maintenant le Treub-Laboratorium, où de nombreux savants sont venus de partout pour se mettre au courant des secrets de la nature tropicale. Je ne saurais ici vous donner une énumération de tous ceux qui, au cours du dernier demi-siècle, sont venus à Buitenzorg et je ne pourrais vous donner un aperçu même sommaire de leurs travaux; tous ont récolté un riche matériel d'études et de démonstration qui a enrichi leurs musées et laboratoires; tous ont publié, à la suite de leur séjour dans le beau jardin tropical, d'importants mémoires qui ont fait honneur à eux-mêmes, à l'Institution qui leur avait fait un bienveillant accueil et au savant maître qui les avait aidés de son expérience.

Parmi tous ces savants, je ne vous citerai que les naturalistes suisses qui ont visité Buitenzorg, en partie grâce à une bourse de voyage instituée par la Société Suisse des Sciences naturelles à la suite d'un voyage de propagande que TREUB avait entrepris dans divers pays pour les convaincre qu'il serait utile pour leurs biologues de compléter leurs études dans une région toute nouvelle pour eux et où ils rencontreraient toutes facilités de travail. Je ne manquerai pas de rappeler tout d'abord HEINRICH ZOLLINGER, qui fit ses études à l'Université de Genève, fut l'élève et l'ami d'A. P. DE CANDOLLE et, encouragé et probablement aussi aidé par DE CANDOLLE, partit en 1841 pour Java, où il séjourna à deux reprises; il y mourut en 1859, âgé de 41 ans, après avoir, au milieu de grandes difficultés matérielles, poursuivi un labeur scientifique considérable. Sa tombe avait été bien négligée, mais en 1919, le Gouvernement des Indes Néerlandaises la fit remettre en état et depuis, elle a été bien entretenue; le Groupe de Batavia de la Nouvelle Société Helvétique a consacré un de ses bulletins à notre compatriote. Les Prof. SCHROETER et ERNST ont visité à deux reprises le jardin de Buitenzorg; les Prof. SENN et TSCHIRCH, Dr PERNOD, les explorateurs P. et F. SARASIN, J. ROUX, WIRZ, ont fait aux Indes Néerlandaises des séjours plus ou moins prolongés; enfin de nombreux biologues Suisses, dont je parlerai tout à l'heure, ont été au service du jardin botanique ou d'autres institutions scientifiques de Java et de Sumatra et ont eu l'occasion de travailler à Buitenzorg. Tous ont fait honneur à nos écoles Suisses de biologie et ont su faire œuvre utile; ils ont trouvé là-bas un riche matériel d'étude, qui donne un démenti aux paroles d'un des grands pontifes de notre petite science botanique, à qui l'on demandait s'il n'irait pas un jour à Buitenzorg et qui répondait, en des termes dont je ne vous rappellerai pas la forme Rabelaisienne: «Aller à Buitenzorg? Mais non, il ne s'y trouve plus une plante qui n'ait déjà été étudiée par quelques botanistes.»

Eh bien, je vous assure que ces mots sont dépourvus de tout sens et qu'il y a encore beaucoup à faire là-bas et surtout qu'on peut y faire beaucoup parce que, dans ce centre scientifique, tout est organisé pour faciliter les recherches. Ils s'en souviennent, tous ceux qui ont eu l'avantage de se promener avec TREUB dans les allées du jardin, aux premières heures fraîches du matin; c'était un émerveillement de l'entendre disserter sur mille problèmes, citer maintes observations inédites, dont chacune pouvait être le point de départ de nouvelles recherches ... et ceux qui ont fait avec BACKER la délicieuse excursion du littoral et de la mangrove près de Batavia; à tout moment cet ingénieux botaniste attirait l'attention de ses compagnons sur un point non encore élucidé de la structure de telle ou telle plante, sur un problème à résoudre de biologie ou de géobotanique . . . Que les jeunes botanistes qui en ont la possibilité aillent sans aucune inquiétude à Buitenzorg; ils n'y manqueront pas de sujets de travail, ils n'auront qu'à ouvrir les yeux, ils pourront à chaque pas faire des observations originales; et, aidés par des hommes pleins d'expérience qui ne leur ménageront pas les conseils, ils ne reviendront pas les mains vides.

Le Laboratoire des Etrangers était une des fiertés de TREUB; il avait pour lui une affection toute particulière; c'est aussi pour aider ses hôtes qu'il créa cette merveilleuse succursale du jardin de Buitenzorg à Tjibodas, un jardin de 30 ha. à 1500 m. d'altitude sur le volcan Gedeh, dans un climat paradisiaque, avec un laboratoire bien installé, une confortable maison d'habitation, à la limite d'une réserve de forêt vierge, d'une étendue de près de 300 ha. et qui, s'élevant jusqu'au sommet de la montagne, à 3000 m., présente toutes les formations végétales de la forêt tropicale, «à caractère démocratique», comme disait TREUB, jusqu'à la flore volcanique et alpine du sommet. On se représente les sensations du botaniste installé à Tjibodas qui, sortant du bungalow pittoresque, n'a que cent pas à faire pour se promener sous les sombres frondaisons de la forêt vierge, dans le fouillis des lianes, des rotins, etc., pour admirer les épiphytes, les dentelles des *Hymenophyllum*, les *Asplenium nidus*, les Rhododendrons aux fleurs vivement colorés et, sur le sol, les Hépatiques aux teintes glauques, et tout d'un coup la tête rouge d'un *Balanophora*; plus haut, après les rochers humides tapissées d'une sphagnaie verticale, après les sources chaudes où des algues résistent à une température incroyable, c'est la splendeur des clairières couvertes de *Primula imperialis*, la primevère aux 5–6 verticilles superposés, sur une hampe pouvant atteindre un mètre; enfin, la flore de haute montagne, avec ses *Vaccinium* géants et l'*Anaphalis* au feuillage feutré, qui est une sorte d'Edelweiss arborescent; sur le sol, des formes alpines, rabougries appartenant à diverses espèces.

Je ne veux donner qu'un exemple, mais bien frappant, de la collaboration intime de TREUB avec les visiteurs du jardin; j'ai dit déjà que, sans être systématicien, il s'intéressait vivement aux problèmes de géobotanique; on concevra donc sans peine que le jeune savant, qui venait d'arriver à Java, fût frappé par l'éruption du Krakatau, l'affreuse catastrophe qui, en 1883, provoqua, par suite de l'explosion et du ras de marée, la mort de 30,000 personnes. Toute la région environnante et en particulier les débris «survivants» du groupe d'îles furent recouverts d'une couche énorme de cendres incandescentes, de sorte que toute trace de vie fut anéantie sur ces rochers abrupts. Le géologue VERBEEK, qui visita le Krakatau quelques mois après l'éruption, n'y rencontra plus aucune trace de végétation. Après quelques années, en 1886, TREUB, supposant que les premiers vestiges d'une nouvelle végétation pouvaient être apparus sur l'île dévastée, se rendit sur place avec quelques-uns de ses collaborateurs et fit les premières constatations: il nota les plantes, encore rares, qui se mon-

traient ici et là et publia des aperçus ingénieux sur la manière dont les végétaux étaient revenus peu à peu sur les lieux de la catastrophe; depuis lors, tous les dix ans environ, il convia les botanistes étrangers qui se trouvaient à Buitenzorg, à répéter avec lui l'excursion au Krakatau, pour constater les progrès de la nouvelle flore; chaque fois d'intéressantes observations étaient faites et consignées dans des publications importantes. En 1896, ce fut PENZIG et en 1906 les Prof. CAMPBELL et PULLE, avec notre compatriote le Prof. ERNST, qui eurent la chance d'accompagner TREUB dans cette intéressante excursion. Après le départ de TREUB, ses successeurs continuèrent la tradition établie par lui: de nouvelles expéditions eurent lieu, qui étudièrent aussi le développement de la nouvelle faune et l'on put, en 1929, à l'occasion du 4me Pan-Pacific Science Congress, tenu à Batavia, et qui fut, à bien des égards, une sorte d'apothéose de l'œuvre de TREUB, faire paraître une publication définitive décrivant la flore et la faune reconstituées du Krakatau. Le nombre des espèces végétales avait passé de 26 en 1886 à plus de 300 en 1929. Sans doute, on a pu discuter les conclusions tirées par TREUB et ses collaborateurs; il n'en reste pas moins que nul n'a pu démontrer l'inexactitude de ces théories qui expliquent la repopulation, en un temps relativement court, d'une île totalement dévastée, la formation d'une végétation drue, où apparurent peu à peu de nombreuses espèces animales. Mais surtout, cette étude montre la belle collaboration que le Directeur du jardin sut maintenir avec les savants botanistes qui venaient travailler près de lui et la manière généreuse dont il les faisait profiter de sa riche expérience personnelle.

TREUB se rendit bien vite compte qu'il ne pouvait faire de son jardin tropical et de ses laboratoires bien installés une institution de science pure, avec des savants planant audessus de toutes les contingences pratiques. Il vit de suite les immenses services que ses laboratoires pouvaient rendre à l'agriculture et à l'industrie. J'ai déjà dit qu'il avait créé des laboratoires de recherches et d'avis pour le riz et le café, deux cultures importantes de la population indigène. En outre, il chargea ses laboratoires botaniques d'entreprendre pour toutes les plantes de grande culture des études de physiologie et de phytopathologie; le musée zoologique se consacra tout spécialement aux insectes nuisibles à l'agriculture; le laboratoire de pharmacologie fit nombre d'observations pratiques; le laboratoire de chimie agricole entreprit les premières recherches sur le caoutchouc et devint par la suite le laboratoire de chimie industrielle et d'analyse; un des chimistes collabora aux études sur les vitamines et prépara le produit appliqué maintenant en grand contre le beri-beri; plus tard fut fondée une station expérimentale avec instituts spéciaux de phytopathologie, de sélection, d'agrogéologie etc. De plus, TREUB développa l'annexe du jardin botanique, dite le «jardin de culture», où il fit planter, sur des parcelles de quelque étendue, toutes les plantes utiles susceptibles de vivre sous le climat de Buitenzorg; on y trouve des individus en quantité suffisante pour faire des expériences soit sur place, soit dans les laboratoires avec les produits obtenus; ce jardin est un véritable musée vivant, où se rencontrent des types historiques: les plus anciennes plantes de thé introduites à Java en 1826 par graines importées de Chine et du Japon; les premiers *Palaquium* mis en culture pour la production de la gutta-percha; quelques vieux individus du premier stock de graines d'*Hevea* importées il y a environ 60 ans; des *Ficus* et d'autres plantes à caoutchouc qui ne présentent plus qu'un intérêt historique; les premiers palmiers à huile importés aux Indes Néerlandaises et qui, sélectionnés, ont fourni des graines pour les immenses étendues plantées d'*Elaïs* à Sumatra; les types de caféier importés pour lutter contre la maladie des feuilles (*Hemileia*), les hybrides, les greffes; les premières greffes réussies d'*Hevea*; des *Erythroxylon coca*, des cacaoyers de divers types, des agaves, des cocotiers; enfin toute la collection des Légumineuses utilisées comme engrais vert et dont l'application, vivement préconisée par les services agronomiques officiels et privés, a certainement contribué à sauver plusieurs cultures en améliorant la constitution chimique et physique du sol, en le protégeant contre l'érosion et en diminuant les frais d'entretien des jardins.

L'énorme extension que prirent les cultures européennes et les innombrables avis demandés aux services agricoles du jardin botanique se développèrent à tel point que le personnel, absorbé d'autre part par les soins à donner aux cultures indigènes, ne pouvait plus, malgré tout son dévouement, suffire à la tâche. TREUB réussit à convaincre les entreprises de cultures qu'elles devaient organiser, à leurs frais, des stations expérimentales qui travailleraient en collaboration avec les services de Buitenzorg et sous le contrôle du Directeur du jardin. Ce furent d'abord les stations pour le sucre et pour le tabac, dont le personnel travaillait une partie de l'année dans les centres de culture, le reste du temps dans le laboratoire mis à leur disposition à Buitenzorg; la station pour le café, qui travaillait pour les cultures du Gouvernement et pour les plantations privées; la station pour la culture du thé, que j'ai eu l'honneur de diriger pendant 20 ans et qui, par une entente avec le Gouvernement, donnait aussi des avis aux indigènes planteurs de thé; la station pour l'indigo, qui disparut lorsque la culture de cette plante succomba devant l'apparition de l'indigo artificielle; la station pour le cacao dans le centre de Java; plus tard naquit encore la station pour l'étude du quinquina, enfin, en 1914, celle pour le caoutchouc.

On se rendra compte sans peine de l'énormité de cette organisation et des difficultés que TREUB eut à surmonter pour la mener à bien: surchargé lui-même par son travail scientifique et par la surveillance des travaux de ses collaborateurs, submergé par l'organisation de ses divers services qui, de jour en jour, devenait plus absorbante, il avait, toujours perdu au milieu de l'administration hybride du Département de l'Instruction publique, à lutter pour son œuvre, pour la coordination des efforts de son nombreux personnel, à lutter avec des chefs, responsables il est vrai, mais souvent incompétents Aussi comprit-il bientôt qu'il ne pouvait, dans ces conditions, s'organiser au mieux de l'intérêt général et songea-t-il à la nécessité de grouper tout ce qui touchait de près ou de loin à l'agriculture, et d'en former un nouveau Département, comprenant, outre les instituts déjà nommés, le service vétérinaire, le service forestier et les établissements existant déjà ou à fonder pour l'enseignement agricole. Vous vous doutez bien que cela n'alla pas sans peine, car la réorganisation est une des choses les plus difficiles qui soient: aux Indes, comme ailleurs, sévit la routine et quand on

parle d'enlever à un chef de Département un de ses services pour le placer sous le contrôle d'une administration plus compétente, aussitôt ce chef, même s'il ne s'intéressait guère au service en question, crie à l'accaparement et ne veut pas lâcher une seule parcelle de ses prérogatives; ce sont les questions de prestige et de personnes qui priment toujours et partout sur les questions de logique et de bon sens. L'affaire se compliquait encore parce que, acceptée finalement aux Indes, elle devait être approuvée en Hollande; bref il fallut à TREUB des luttes épuisantes et une persévérance inlassable pour atteindre son but: il l'atteignit pourtant et le 1er Janvier 1905, le Département de l'Agriculture était institué. Plus tard, on lui adjoignit encore l'Industrie et le Commerce, avec le bureau de statistique, le contrôle des poids et mesures, le musée de botanique économique, les pêcheries, etc., etc. Plus tard enfin, sous l'influence de la crise qui sévit actuellement, on crut nécessaire de coordonner certains services ou de les combiner pour réaliser les économies et les restrictions indispensables; on pensa ainsi augmenter leur efficacité et on donna au Département le nom de Département des Affaires économiques; question de mots, qui ne changea pas grand chose à son activité.

Dès 1905, le Département s'était développé peu à peu normalement; c'est surtout par la collaboration de ses services et de l'administration civile qu'on réussit à faire progresser les cultures indigènes, grâce à l'excellent corps des ingénieurs agricoles chargés de donner régulièrement des informations aux petits agriculteurs, grâce aussi à l'enseignement agricole qui forma les fonctionnaires indigènes. Le service forestier s'améliora lui aussi et travailla utilement à la formation de grandes réserves forestières, au reboisement de régions importantes, à l'exploitation rationnelle des forêts; une station expérimentale fut installée et contribua largement au développement normal de ce service; il en fut de même du service vétérinaire, avec son laboratoire pour la préparation des sérums, sa policlinique et son école moyenne pour la formation de vétérinaires, spécialisés dans les questions concernant les animaux domestiques des tropiques, l'amélioration des races, le traitement des maladies, etc.

Les plantations de caoutchouc et de guttapercha et l'exploitation des forêts de teck, bien dirigées, donnèrent dans les bonnes années de beaux bénéfices au Gouvernement; hélas, depuis que la situation économique est devenue si précaire, cette source de revenus s'est peu à peu tarie; espérons que le temps des vaches grasses finira par revenir.

TREUB, qui avait compris que pour toutes les branches de l'activité économique les mêmes méthodes devaient être appliquées, avait pensé qu'un service de recherches et d'informations scientifiques serait utile aux pêcheurs et il installa à Batavia un aquarium et un laboratoire d'océanographie qui fit œuvre utile et acquit une grande importance; cet institut travailla en intime collaboration avec le service d'hygiène en vue de la lutte contre la malaria, par des modifications apportées à la biologie des poissons dans les viviers au Nord de Batavia, viviers où pullulaient les larves de moustiques; la collaboration des deux services réussit à assainir dans un délai très court cette partie insalubre de l'île; mais c'est là une question à laquelle je ne m'arrêterai pas, car elle pourrait à elle seule faire l'objet d'une conférence.

Bref, le Département de l'Agriculture qui, à sa fondation en 1905, roulait sur un budget d'environ sept millions de florins, s'était développé à un tel point que, lorsque j'en étais le Directeur en 1930 et que nous fêtions le 25me anniversaire de sa fondation, il pouvait disposer de 33 millions de florins. On voit la progression et le beau développement de cette organisation au cours de ce quart de siècle; malheureusement, plus tard, les économies et les restrictions, les diminutions de personnel ont bien dû intervenir et ce budget, qui permettait un si magnifique essor des divers services, a du être réduit de près de 50%.

Comme je l'ai dit, il existait au début, entre le Département et les Stations expérimentales privées pour les grandes cultures européennes, un lien plus ou moins solide; TREUB avait obtenu que ces stations, entretenues par les contributions des planteurs, travaillassent sous sa direction; il voulait ainsi soustraire le personnel scientifique à l'influence trop directe des intérêts de la pratique et assurer l'indépendance scientifique des employés; mais peu à peu, les planteurs trouvèrent qu'ils avaient trop peu à dire dans ces institutions, pour lesquelles ils s'imposaient de lourds sacrifices et ils exprimèrent le désir de les voir s'installer près des centres de cultures; ils pourraient ainsi prendre une part plus grande aux recherches et expériences et surtout mieux organiser les applications pratiques. Le sucre et le tabac de Sumatra se séparèrent les premiers du Département; des stations expérimentales privées se fondèrent pour le café, le caoutchouc dans le centre et l'est de Java, une grande station fut établie pour toutes les cultures autres que le tabac à Medan, sur la côte orientale de Sumatra; la station pour le thé et celle pour le quinquina furent les dernières à suivre ce mouvement et c'est en 1926 seulement, que la station pour le thé rompit le dernier lien qui l'attachait au Département de l'Agriculture; bien entendu, toutes ces stations sont toujours en collaboration intime avec les services du Gouvernement et elles continuent à profiter des avantages offerts par le centre scientifique de Buitenzorg: l'herbier, le musée zoologique, les bibliothèques, le nombreux personnel bien dressé aux recherches de physiologie et de phytopathologie. Une association groupe le personnel technique du Département et des Stations expérimentales et le réunit une fois par année en des séances où sont traités des subjets intéressants et qui assurent un contact permanent et une collaboration féconde en résultats pratiques.

Je pense que beaucoup d'entre vous savent ce qu'a été, dans les 50 dernières années, le travail de ces stations expérimentales; de toutes sont sortis de nombreux mémoires sur les problèmes les plus divers qui se posent pour les cultures tropicales: le travail du sol et les engrais; la sélection; le traitement ultérieur des plantes; les semis, pépinières, greffes, la taille; les dommages causés par des insectes, des champignons, des défauts de culture, etc.; la récolte du produit, et son traitement dans les usines; enfin les questions économiques. Tous ces sujets sont traités devant les assemblées de planteurs, puis dans de nombreuses publications, les unes de caractère plus scientifique, les autres nettement pratiques. Le travail de ces institutions, leur organisation, ont fait l'admiration de tous ceux qui sont venus visiter les Indes Néerlandaises et on les a souvent citées en exemple dans beaucoup de pays où, sur

leur modèle, des institutions analogues ont été fondées.

Au cours des années écoulées, de nombreux biologues Suisses ont travaillé dans les laboratoires agricoles soit gouvernementaux, soit privés; je nommerai d'abord un des pionniers des recherches agronomiques, le Dr ZEHNTNER, qui a longtemps dirigé une station de recherches dans le centre de Java; puis un de ses collaborateurs, le regretté Dr WURTH, trop tôt enlevé à ses chères études et qui fut un spécialiste éminent de la culture du café; dans le caoutchouc se sont distingués VISCHER, STEINMANN, SCHWEIZER, BOBILIOFF, à Sumatra HEUSSER et FREY; dans le cacao BALLY et HALLAUER, dans le tabac, DIEM à Sumatra, VON SPRECHER à Java, en chimie LONG et ZIMMERMANN, en minéralogie SCHEIBENER; en systématique HOCHREUTINER, qui travailla 3 ans à l'Herbier de Buitenzorg; en phytopathologie GÄUMANN et PARAVICINI; moi-même, j'ai dirigé pendant 20 ans la station expérimentale pour le thé et j'ai eu le plaisir de compter parmi mes collaborateurs deux compatriotes, le Dr STAUB qui a étudié la fermentation du thé, plus tard le Dr MENZEL, entomologue, qui a étudié avec passion les insectes nuisibles du théier et du quinquina. Je pense que tous ont emporté de leur séjour à Java un bon souvenir, souvenir de travail utile et intéressant, souvenir d'une vie large et agréable, comme eux-mêmes ont laissé là-bas une réputation de bons travailleurs. Malheureusement, les conditions ont tellement changé, le personnel des instituts agronomiques a été tellement réduit, on a si parcimonieusement remplacé ceux qui s'en allaient que, sauf deux ou trois compatriotes qui continuent à exercer à Java une féconde activité, tous sont rentrés au pays; comme, dans les circonstances actuelles, si difficiles dans tous les pays, on n'engage plus guère que les biologues Hollandais, ce débouché, comme tant d'autres est malheureusement fermé à nos jeunes naturalistes, dont la situation, au début de leur carrière devient de plus en plus précaire, puisqu'ils ne peuvent plus trouver les possibilités de travail offertes autrefois à leur activité dans les pays étrangers qui leur sont maintenant fermés.

Si, Mesdames et Messieurs, je n'ai pas traité de sujets vraiment botaniques, qui auraient peut-être intéressé davantage les membres de notre société, si je ne vous ai pas parlé des plantes, si je ne vous ai pas décrit les recherches faites au laboratoire ou à l'herbier par les nombreux savants qui ont étudié la flore tropicale, je pense vous avoir cependant indiqué les possibilités botaniques qui ont existé, qui existent encore dans ce grand et riche domaine des Indes Néerlandaises et l'organisation des recherches à Buitenzorg, tant au point de vue purement scientifique qu'à celui de l'application pratique, dans l'intérêt des cultures.

Je voudrais avoir réussi à vous intéresser, à vous faire admirer l'œuvre coloniale des Hollandais, à vous faire aimer ce beau pays, je voudrais avoir inculqué aux jeunes biologues le désir d'y aller compléter leurs études, entreprise qui, malheureusement, est bien plus difficile pour eux que pour leurs devanciers immédiats . . .

# ON THE CLIMATE OF AND METEOROLOGICAL RESEARCH IN THE NETHERLANDS INDIES

*by*

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The most prominent quality of the tropical climate is its monotony, its uniformity from day to day. The sudden changes of temperature and wind, characteristic of the climates in the temperate zone, are absent in the East Indies and the weather hardly counts as a topic of conversation.

Where no oppressive heat is felt, as is the case in the tropical mountains, the climate is the finest an inhabitant of the temperate zone can imagine. Still, in this ideal climate one longs at first for the changes between the mild south and the cold north wind, the regular succession of the seasons, of storm and calm weather. In the long run, however, one is no longer aware of this privation, and gets so accustomed to the fine weather that after a long residence one prefers the Indies to the home country and does not repatriate any more.

The climate of the tropical zone, which covers nearly half the globe, is rather uniform, but its differences are often overlooked by meteorologists and physicians, who, dealing with the influence of climate on man, do not make sufficient distinction between a climate with a mean temperature of 20° C. and another with one of 26°. This difference can only be appreciated by those who, after a residence in the hot tropical plains, visit the highlands with their bracing climate. For instance, when one leaves Batavia, which has a mean temperature of 26°, and visits Bandoeng, which has a mean temperature only 4° C. lower, the sensation of oppression, which is felt in the plains, vanishes entirely, and many Europeans, who left Batavia on account of the oppressive heat, feel quite at ease and cheerful at Bandoeng and prefer a stay there to one in Holland with its more inhospitable climate.

Apparently one degree of temperature counts more in the case of temperatures approaching the limit of human endurance, as in the low-lying plains, than at lower temperatures.

This great sensibility to temperature differences involves, that in describing the climate of a tropical country, stress should be laid in the first place on the temperature conditions, and especially on the variation in connection with height, because the variation in a horizontal direction is slight.

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**General Features of the Indian Climate:—** The dimensions of the islands of the East Indian Archipelago are still small enough to allow of an effective interchange of air with the surrounding seas. Consequently the climate resembles that of the ocean near the equator. Abundant rainfall, light winds, high temperature and high humidity are therefore the principal features of the climate of the E. Indies plains.

This, however, is only approximately true, the exceptions to the general rule being by no means negligible.

The influence of the continents of Asia and Australia renders the Archipelago the most typical monsoon region in the world. The change of the monsoons causes an annual variation in the climate, which is fairly small in the northern, but considerable in the southern part of the Archipelago.

Added to this seasonal variation are the local differences, which are relatively large on account of the mountainous character of the country, which makes rainfall and cloudiness to a high degree dependent upon the direction of the wind.

Moreover, in successive years differences occur in the force of the monsoons which are closely connected with the general air-circulation. Consequently the differences between the seasons may vary appreciably, so that in some years the farmer will wait in vain for the dry season, whereas in other years he will look out for months and months for the first good shower.

With the exception of the fluctuations of rainfall, the variations from day to day are trifling. Disturbances, such as the low-pressure systems of the higher latitudes, which make the weather very variable, are practically unknown. The deviations of air pressure do not even exceed a few millimetres, and hardly affect the weather.

Strong winds are exceptional. By far the most important are the variations in rainfall, and it is chiefly by the intensity of the tropical cloudbursts that the inhabitants of this land of eternal summer are reminded of the power of the elements.

The variation of the phenomena is very much the same from day to day. When the sun has risen in the clear sky and has stirred the air by its heat, the small cumulus clouds begin to appear, usually at about 9 o'clock; at the same time the monsoon, which had almost completely died down during the night but had kept blowing in the higher air layers, springs up again. Windforce and cloudiness increase as the sun climbs higher, the clouds grow denser and darker, pile themselves up to higher and higher levels, till in the afternoon condensation sets in, and the refreshing rain falls down with a pattering sound on the thick foliage, or till, towards the close of a rainless day, the clouds gradually dissolve with the declining force of the sun beams. Then the evening succeeds the short summer day, the sky clears up, the wind abates and the cloudless and calm tropical night begins, bringing relief after the oppressive heat of the day.

The uniformity of the temperature conditions makes the differences between the climate of the higher regions and that of the low plains the more prominent. In addition to the decrease of temperature of from 5½ to 6° C. for a rise of 1000 metres, the climate also changes in other respects with increase of height. In the mountains cloudiness increases and at first also the amount of rain. On reaching higher levels the intensity of the rains becomes smaller, but the total duration of showery weather increases, instead of the heavy tropical cloudbursts light showers becoming more frequent.

The weather is very variable on the high mountain tops. When the air is calm and the intensely radiating sun is not obscured by clouds or fog, one feels almost too hot. But as soon as a fresh breeze springs up and blows away the thin layer of warm air that surrounds the mountain, the temperature may fall several degrees, and one suddenly feels shivery. When the clouds cover the summit and shut out the sunlight, the weather becomes at once chilly and dull, but when the mist has cleared and the atmosphere is again filled with light, the depressing state of the weather changes as if by magic into the merriest summer day.

Thunder is very frequent on the mountain slopes but it is seldom observed on the high tops. The thunderclouds, which originate on the lower slopes, repelled as it were by the mountain, take their course towards the plain. It often occurs that on all sides high clouds tower above the summit, whereas the latter is left free and still basks in the sun.

**Comparison of the Climate with that of the Neighbouring Countries:—** Although the heat of the coast plains is far from pleasant, yet the climate compares favourably with that of our neighbours at a greater distance from the equator.

As a matter of fact, the mean annual temperature decreases as the latitude increases, but the favourable effect of the cooler winter months is more than counterbalanced by the unbearable heat of the hottest summer months. In this case a more equable temperature distribution over the year is better than the more usually praised variety.

We may conclude from the wet-bulb temperatures that there exists on both sides of the equator a zone with more oppressive weather in the hottest month than is found on the equator. The following figures, which represent the mean wet-bulb temperature in the hottest month, may serve as a proof.

| Batavia | Shanghai | Manila | Hongkong | Port-Darwin |
|---|---|---|---|---|
| 24.°4 | 24.°8 | 25.°2 | 25.°4 | 25.°4 |

| Nha-trang (Annam) | Bombay | Madras | Calcutta |
|---|---|---|---|
| 25.°8 | 25.°9 | 26.°2 | 26.°4 |

| Lahore | Hanoi (Tonkin) |
|---|---|
| 26.°6 | 26.°9 |

Whereas at Batavia the maximum heat, although disagreeable, can be endured without too much discomfort, the same cannot be said of most of the other places. At Calcutta for instance the climate is almost unbearable at the most oppressive time of the year.

There is still another difference of much importance in favour of the East Indies. It is the fact that, owing to the small distance from the equator, practically no destructive tropical cyclones occur in the Archipelago, and, moreover, the heavy storms of the temperate zone need not be guarded against. Wind spouts can develop a destructive force, but they are so local and therefore so rare, that they need scarcely be taken into account. For these reasons, there is no safer place for navigation at sea than these regions and on land less strong building constructions are sufficient as compared with other parts of the world.

FIGURE 8. — THE ROYAL METEOROLOGICAL OBSERVATORY IN BATAVIA (*circa* 1928).

**Observations:**—The period of regular and trustworthy meteorological observations begins with the foundation of the Observatory at Batavia in 1866. Under its first director, Dr. BERGSMA, a system of 74 rainfall stations was established in Java and of 44 on the other islands, in addition to the meteorological and magnetical observations, made at the Observatory. The number of these stations has been regularly increased in course of time and at the present moment the Observatory receives the observations from more than 3000 rainfall stations. Dr. VAN DER STOK compiled the observations made on board men of war from 1814 till 1890 and published the results in "Wind and Weather, Currents etc.", Batavia 1897. Since 1908 a great many observations of the upper air were made, particularly by Dr. VAN BEMMELEN, comprising observations of wind, temperature and humidity up to great heights. As director of the Observatory, VAN BEMMELEN established a system of secondary meteorological stations, distributed over the whole archipelago, their height ranging from sea level to a height of 3000 metres, on Mount Pangerango. A number of 42 of these was in operation in 1918. These observations provided the material for my treatise on the "Climate of the Netherlands Indies" from which the greater part of the contents of this paper has been taken. Several treatises, based on the rainfall observations, were written by Dr. VAN BEMMELEN and Dr. BOEREMA. Dr. BOEREMA has taken charge of the observations of the intensity of the sunlight; a great many of these are available and are being compiled for publication. A good deal of work has been done with more or less success on the problem of seasonal weather forecasting; Dr. BERLAGE, who took over this investigation during the last two years has made some valuable progress.

**Wind and Air Pressure:**— The monsoons are very well developed in the Archipelago. The trade wind system of the tropical oceans is disturbed by the influence of the continents of Asia and Australia, which in the summer of their hemisphere draw the air from the opposite hemisphere across the equator, thus causing one monsoon season with SE. wind on the southern and SW. wind on the northern hemisphere, and one with NE. wind in the N., passing the equator and changing to NW. in the southern part of the Archipelago. The monsoon changes do not occur exactly at the same time, over the whole region and in various years, most frequently, however, in March or April and in November.

Two charts are inserted here, representing the mean air pressure and mean wind direction and force in the west-monsoon months, December—February, and the east-monsoon months, June—August, which were compiled at the Royal Dutch Meteorological Institute from observations, made on board of ships.

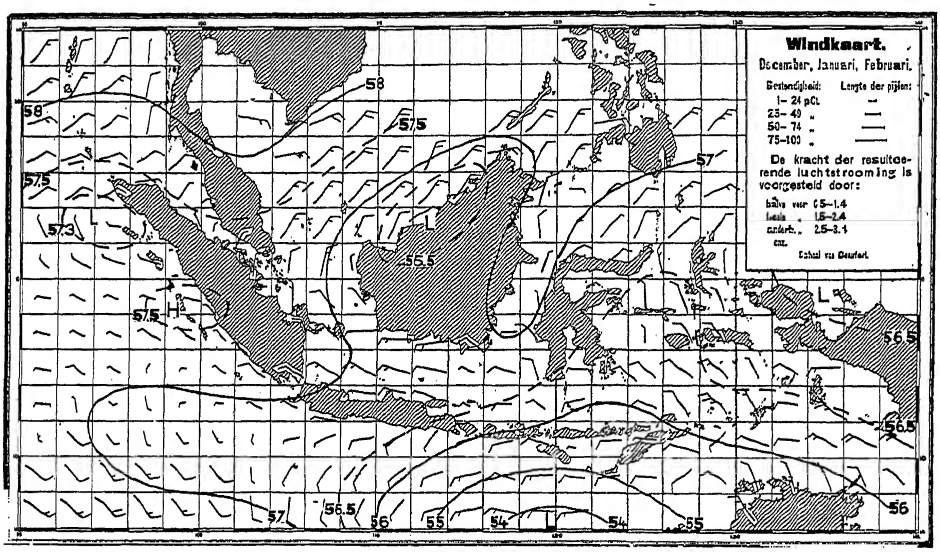


FIGURE 9. — AIR PRESSURE AND WIND IN DECEMBER-FEBRUARY.

In the open sea the steadiness of the monsoons is fairly great, reaching about 90% when the east or west monsoon have attained their full development.

In those months the wind system is also very regular, with respect to the wind velocity. The average wind force is remarkably high in those months, the mean wind velocity observed at 23—28 metres of height on the Indies lighthouses in the open sea being 9 metres per second in the most windy months.

The lightships in the North Sea near the Dutch coast record no higher figure for the mean velocity in the most stormy month. The mean velocity for the whole year is even higher on the Indies lighthouses than on the Dutch lightships, being from 6 to 7 metres per second in the first and from 5 to 6 metres in the second case. How is it possible that in spite of this the wind has the reputation of being generally light in the tropics? We get a satisfactory answer when we take into account that the velocities observed in the Indies seas become smaller when reduced to normal height, and when we consult the wind observations, made on land. At Semarang, quite close to the sea, the mean wind velocity is only 3.0

m. p. s., and at Batavia, at 10 km from the sea it is 1.1 m. p. s., at the mountain station of Tosari 2.2 m. p. s.

A very important fact, in favour of the Archipelago, is the absence of very strong winds. In a period of 5 years, chosen at random, the highest daily mean of wind velocity was 3.2 m. p. s. at Batavia, against 12.8 m. p. s. at the Dutch Meteorological Institute at de Bilt (Holland), the highest hourly means being 5.3 and 26.0 m. p. s. Whereas on the Dutch coast mean hourly velocities of 32 m. p. s. have been observed, the highest hourly means observed on the lighthouses in the Indies seas are probably not much higher than 16 m. p. s.

This means that the wind velocity hardly ever surpasses that of a fresh gale, the consequence of which is a high degree of security in navigation, in comparison with the regions of the tropical cyclones at some greater distance from the equator, or with the temperate latitudes with their travelling systems of low barometric pressure.

Land and sea breezes have a great influence near the coast, up- and down-valley winds in the mountainous interior. Where the monsoons are light, those winds dominate the whole wind system. On the west coast of Sumatra the influence of the land and sea breezes extends to a distance of more than 100 kilometres from the shore, in the Java Sea to some 70 km from the Java coast. At the base and on the slopes of the high volcanoes the mountain and valley breezes are usually stronger than the monsoons.

It is quite natural, after what has been said about the wind, that its cause, the differences of air pressure, are relatively small and that the variations in the pressure system are much more regular than in higher latitudes. The insignificance of these changes may be demonstrated by the fact that the highest barometer reading at Batavia, 764.4 mm, does not differ more than 12 mm from the lowest, 752.4 mm. Barometric lows such as occur in temperate latitudes are unknown; the small aperiodic variations which occur are ups and downs of barometric pressure which are met with almost simultaneously over the whole Archipelago.

The absence of great disturbances makes the regular diurnal variation and the variations of long duration the more prominent. The latter, of which those with a period of about 3 years are the most important, have a great influence on the climate, though their amplitude is only 1 mm from maximum to minimum. These changes are used as a base for a long-range weather forecast.

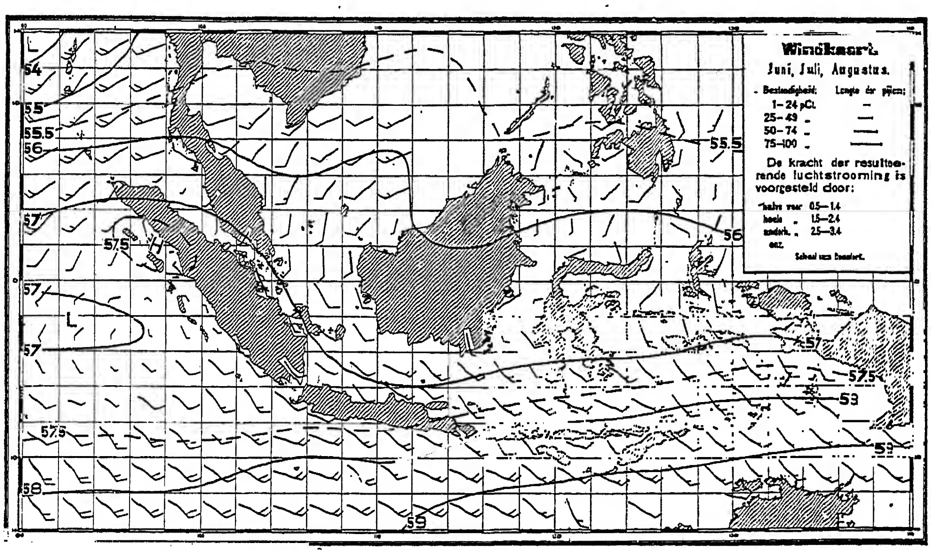


FIGURE 10.—AIR PRESSURE AND WIND IN JUNE–AUGUST.

**Temperature and Humidity:**—The average annual temperature at sea level can be fixed at 26° C. for the whole Archipelago, the deviations from this mean value being only a few tenths of a degree for the various stations. The temperature is fairly uniform during the whole year. There is a slight variation, however, lower temperatures occurring in the winter season of the corresponding hemisphere, higher temperatures in the summer season. In July and August the temperature falls about 1.°5 C. from Pontianak and Menado in the north to Kupang and Ambon in the south; in January and February there is a still smaller fall in the opposite direction. Besides this annual variation of winter and summer, the temperature becomes relatively high twice a year in the monsoon changes, shortly after the sun has passed the zenith.

The highest temperatures are observed on the north coast of East Java and in Madura, towards the close of the dry season; Surabaja has a mean temperature of 27.°5 in November.

The lowest temperatures are found in the southeast in the dry season; Kupang has a mean temperature of 25.°0 in July. At that time of the year the weather is strikingly cool, when measured by the tropical standard, in the southeastern part of the Archipelago, owing to the cooperation of low temperature and low humidity.

The temperature in the higher zones of the country can be calculated from the sea level tem-

perature with a fair degree of accuracy, by subtracting 0.°6 C. for every 100 metres of height. Thus taking 26.°2 as a mean temperature at Batavia (8 m) we find for Bandung (730 m) 21.°9, for Tosari (1735 m) 15.°8, the actual figures being 22.°1 and 15.°9.

One of the principal characteristics of the tropical climate lies in the slight changes of temperature, not only from season to season, but also from day to day. Taking the differences between the mean temperature of the hottest and coolest day at Batavia for every month, we get an average of only 2.°7 C. for this monthly oscillation of temperature. The difference between the highest and lowest daily means of the whole series of observations, being 28.°7 and 22.°3, is only 6.°4. The average difference for the year is 4.°5.

The principal temperature changes are due to the diurnal variation. The daily oscillation at Batavia is 7.°3 for the whole year, varying from 5.°8 in February to 8.°6 in August and September. In the interior it is generally greater, at Bandung for instance 9.°3 for the whole year, 6.°9 in January and 4.°4 in August.

The highest maximum temperature has been observed at Sawahan, in Central Java, viz: 38.°6 (October), the lowest minimum temperature −2° was observed on the level parts of the high plateau of Pengalengan (1550 m) in the dry season. Probably still lower temperatures have occurred in sheltered basins of great height during calm dry nights.

Generally speaking, the mean monthly values of relative humidity do not vary greatly. They lie, as a rule, between 85% and 90%, with the exception of the dry months in the region with a well-developed dry season. At the coast stations the mean relative humidity in the driest months varies from 87% at Tarakan in East Borneo to 67% at Pasuruan on the north coast of East Java. The highest mean monthly figures are 96% in September and December on M. Singgalang in Central Sumatra, 95% in February at Kawahtjiwidei in the mountains of West Java, and 94% in January on M. Pangerango in West Java.

The lowest yearly average, 77%, is found at Pasuruan; the highest average, 93%, on the summit of M. Singgalang, one of the wettest points in the world.

The absolute minimum of relative humidity, 6%, has been observed on M. Pangerango.

**Rainfall:**—The Archipelago is characterized by abundant rainfall. A great part of the mountainous regions receives more than 3000 millimetres a year, and more than 2000 millimetres fall in large areas of the coast plains. A yearly amount of less than 1000 millimetres is quite exceptional and has been observed at only two stations on the N. coast of East Java, at Waingapu on the isle of Sumba, and in the Palu Bay near Donggala (Celebes). The smallest annual amount on record is 530 mm, at Palu, situated at the extremity of the Palu Bay; the highest amount, 6830 mm, has been measured at Kranggan (Central Java) in the mountain saddle W. of M. Slamat.

The highest monthly totals are found, where a wet monsoon current is forced up against a mountain slope. In some cases an average of 1000 mm falls in one month, for instance on the NW slope of M. Tjereme in West Java (Sadareke 1002 mm in January), and the W. slope of M. Muria in Central Java (Batealit 1001 mm in January). On these mountainsides the highest amounts in 24 hours generally exceed 350 mm; on the W. slope of M. Muria they exceed 400 mm.

Very small quantities of rain fall in the dry season in the SE. of the Archipelago. At Kupang in Timor 69 mm of rain fall during the 6 consecutive driest months. At Kupang rain falls once in 3 years on an average, in August and September. In 1914, an extremely dry year, the monthly rainfall at a few stations on the N. coast of East Java was 5 mm or less during 6 months.

The monsoons cause great differences of rainfall between the wind and lee sides of the mountains. An extreme case is found on M. Idjen in East Java, where in August the mean rainfall at Asembagus (40 m high) and Kajumas (930 m), on the N. side, is 1 and 18 mm respectively, whereas 418 mm falls at Pakudo (660 m) on the S. side.

Though the rainfall is so considerable, the time during which it falls is relatively short, on account of the great intensity. The greatest amount of rain falls during heat thunderstorms and therefore the rainfall has usually a well-defined diurnal variation, most of the rain falling in the afternoon. Hence even in the rainy season the early morning hours are practically rainless in the more sheltered parts of the interior. At Buitenzorg, in July—September, the probability of rain is nearly 100 times greater between 4 and 8 in the afternoon than between 3 and 10 in the morning.

The highest rainfall intensities during short periods are very much the same in the tropics and in temperate latitudes; for longer intervals, however, the tropical intensities are higher. The principal difference with the temperate latitudes consists in the much greater frequency of heavy showers in the tropics; the percentage of rain, discharged by showers of at least 1 mm per minute during a period of not less than 5 minutes is 10 times as large in the Indies as in Bavaria (Germany).

**Cloudiness and Sunshine, Haziness:**— In the SE. part of the Archipelago the mean percentages of sunshine exceed 90% in the driest months. The sun burns the whole day in the clear or lightly clouded sky, the rivers dry up, the grass withers and the soil cracks. Nature lies asleep for the greater part, the green trees contrasting strangely with the poor vegetation on the desolate fields and along the scorched roads.

In the rainy season, however, and in the other parts where the rains are more equally distributed over the year, the climate is not particularly sunny, though generally speaking the percentage of sunshine is higher than in the summer months of Western Europe. Pontianak in Borneo, for instance, has an annual percentage of 59% which is about 10% more than at de Bilt in Holland in June and July. Batavia has 50% in the rainy months of December and January.

A characteristic feature of the tropics is the well-marked diurnal variation of the cumulus clouds. They usually begin to form at about 9 o'clock and grow denser and darker, till in the afternoon condensation sets in or till the clouds gradually dissolve in the evening or in the afternoon.

The clearing up of the sky is a common occurrence in the afternoon in coast places. In the interior, and particularly in the mountains, the percentage of sunshine decreases gradually during the afternoon, thus rendering this part of the day rather dull and chilly. In contrast, however, to the afternoon, the mornings in these regions are

generally bright; the early morning hours are extremely pleasant in the mountains. Hardly any wind is felt, so that one can fully enjoy the bracing influence of the cool air, the heat of the morning sun being sufficient to remove any disagreeable sensation of cold.

The degree of cloudiness increases with the height above sea level. The following annual means of sunshine percentage at some stations in West Java may serve as an example.

Batavia (8 m high) 68%, Buitenzorg (240 m) 63%, Tjipetir (570 m) 52%, Pasirsarongge (1200m) 49%, Tjibodas (1400 m) 43%, Mount Pangerango (3020 m) 41%. In the dry season, however, the summit of Mount Pangerango reaches above the zone of maximum cloudiness, the percentages for the months July—September being 79, 76, 63, 61, 57 and 61% respectively.

The intensity of the tropical sunshine has often been overestimated. In reality it is scarcely higher at noon than in the temperate latitudes in the midsummer, and with the same height of the sun it is even less high at Batavia than at Washington, on account of the greater amount of moisture in the tropics. The intensity increases with the height above sealevel, being about 30% higher on the summit of M. Semeru (3670 m) than at Batavia. Notwithstanding its increase with height the intensity of the light can be borne much better in the mountains than in the plains, because it is combined with a lower air temperature.

There exists a typical difference between the wet and the dry season, with regard to the transparency of the air. In the rainy season the air is transparent and the contours of the mountains are sharply outlined in the clear morning sky. This is most obvious towards the end of the wet season, when the cloudiness begins to decrease. In the dry season, however, the sky loses its clear blue colour and assumes a hazy white tint, the outlines of the mountains becoming indistinct. Therefore, a man who wants to see Java at its best and is not afraid of some rain should see it in the west monsoon, or better still, in the months following it (March—May), before the really dry season, when the transparent air shows the colour effects of the luxuriant landscape to their best advantage.

**Thunderstorms:**—Thunderstorms are generally of frequent occurrence in the Archipelago, particularly on the slopes of the high mountains. The seasons most favourable to their formation are the monsoon changes, when the air is calm and relatively warm and the vertical air currents rise to great altitudes.

By far the greater part of the thunderstorms are heat thunderstorms. They are, consequently, relatively short-lived and of relatively small extension.

Near the foot of the high volcanoes where nearly every afternoon high clouds are formed on the mountainsides, thunder is heard almost every day. At Buitenzorg, for instance, thunder is heard on 322 days of the year, in the rainy season daily, and even on most days in the dry season. It is heard between 5 and 6 in the afternoon on 250 days a year, but never from 3—8 a.m. The number of days with thunder is less high at Batavia, but yet 6 times as high as in Holland, the numbers being 133 for Batavia and 22 for de Bilt (Holland).

Fortunately the danger of being struck by lightning seems to be relatively small in the tropics. Though the cases of damage by lightning are not at all rare, yet the effect of the lightning discharges is generally not so serious as in the temperate latitudes. The following case may be mentioned as an example. Every year some Kanari trees, bordering the famous avenue in the botanical gardens at Buitenzorg, are struck by lightning. This becomes apparent by the fact that the leaves of some of the branches wither and fall off; however, neither the trees nor the branches die. In most cases the branches bud anew after a month or longer.

**The Climate of Batavia and Bandung:**—We shall conclude this paper with some climatological data of Batavia and Bandung. Batavia may be taken as a representative of the warm coast plains, Bandung of the plateaus in the interior at moderate height.

The heat is very uniform at Batavia, the most sultry months being those of the monsoon change in the first part of the year, April and May, which count many a day when complaints about the heat are general. During the remaining part of the year, with the exception of some days in the second monsoon change, those days are rare, and healthy persons bear the heat without discomfort. As a rule, the nights are not so cool that a blanket is necessary, with the exception of the rainy weather in the west monsoon, and the latter part of the night in the driest period of the east monsoon, when radiation lowers the temperature more than normally. The mean monthly values of air temperature and wet-bulb temperature in C°., relative humidity and sunshine in %, and rainfall in millimeters are given below.

The mean daily maximum of temperature varies from 31.°1 in September and October, and 28.°8 in February, the mean daily minimum between 23.°3 in April and 22.°1 in August. The corresponding values for the wet-bulb temperature are 26.°5 in April and 25.°3 in August for the maximum, and 22.°9 in April, 21.°4 in August for the minimum.

The great uniformity in the temperature variation from day to day allows of a thorough accommodation to the climate with respect to clothing and mode of living, and it is probably due to this that cases of sunstroke are comparatively rare.

The wind is light as a rule, there are well-defined monsoons and well-developed land and sea breezes. The land breeze is hardly felt at the surface, the sea breeze blows with fairly good vigour, particularly in the last months of the dry season, except only on very cloudy days.

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Air temperature..... | 25.4 | 25.4 | 25.8 | 26.2 | 26.4 | 26.0 | 25.8 | 25.9 | 26.2 | 26.3 | 26.0 | 25.7 | 25.9 |
| Wet-bulb temp...... | 23.9 | 24.0 | 24.2 | 24.5 | 24.4 | 24.0 | 23.5 | 23.3 | 23.5 | 23.8 | 24.0 | 23.9 | 23.9 |
| Rel. humidity....... | 87 | 88 | 86 | 85 | 84 | 84 | 81 | 79 | 78 | 80 | 83 | 85 | 83 |
| Sunshine........... | 45 | 47 | 61 | 68 | 69 | 69 | 72 | 74 | 71 | 66 | 57 | 48 | 62 |
| Rainfall............ | 313 | 322 | 207 | 139 | 107 | 96 | 70 | 42 | 73 | 114 | 146 | 199 | 1828 |

In the months of April—October the rains are concentrated chiefly on the afternoon hours, and are rare in the morning hours. In the west monsoon, however, the fairly frequent rains in the morning not seldom give some trouble to persons going to their offices.

Bandung, lying at 700 metres above the sea, may serve as a representative of the Preanger Uplands, which constitute the fairly level central part of West Java, the height varying between 500 and 700 metres. By its moderate temperature the climate differs essentially from that of the low plains.

In consequence of the sheltering influence of the surrounding mountains, the rainfall is relatively small on these high plains and they receive a greater amount of sunshine than corresponds with their height. The climate is praised generally; it is cool but not too cold for people who adhere to habits contracted under tropical conditions.

Mean values of air temperature, wet-bulb temperature, relative humidity, sunshine and rainfall at Bandung follow here.

The mean daily temperature maximum varies from 28.°7 in October to 26.°1 in January, the mean daily minimum from 19.°2 in January to 16.°7 in July and August.

Though an air temperature of 22° and a wet-bulb temperature of 20° is by no means low according to non-tropical standards, the more or less oppressive sensation that is given by the Batavia climate, is entirely absent at Bandung, at least in the conditions under which Europeans live and work there. At this height above sea level one again begins to enjoy the sunlight instead of shutting it out as much as possible, as is done at Batavia. The morning is mostly clear and calm, though fog or low-drifting clouds are by no means rare. In the course of the day the cloudiness increases gradually. During the whole year the probability of rain is much higher in the afternoon than in the morning.

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Air temperature..... | 22.0 | 21.9 | 22.0 | 22.3 | 22.3 | 22.0 | 21.9 | 22.0 | 22.4 | 22.5 | 22.3 | 22.1 | 22.1 |
| Wet-bulb temp...... | 20.2 | 20.3 | 20.4 | 20.6 | 20.4 | 19.7 | 19.1 | 18.9 | 19.3 | 19.8 | 20.2 | 20.2 | 19.9 |
| Rel. humidity....... | 84 | 86 | 85 | 84 | 83 | 81 | 77 | 75 | 75 | 78 | 83 | 84 | 81 |
| Sunshine........... | 52 | 51 | 55 | 61 | 66 | 70 | 77 | 75 | 70 | 62 | 54 | 50 | 62 |
| Rainfall............ | 193 | 181 | 243 | 229 | 133 | 92 | 65 | 58 | 91 | 170 | 227 | 216 | 1898 |

# VOLCANOLOGY IN THE NETHERLANDS INDIES

*by*

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Volcanic activity has played an important part in the destiny of the Indonesian archipelago. It has to a great extent influenced the recent geological history of the entire region and is responsible for its remarkable fertility. Without the decomposition of volcanic ashes, Java's rice wonder would not have been a reality nor Java's population as dense as it now is. The high mountain tops have attracted the abundant rainfall and otherwise influenced Java's climate and vegetation. No irrigation would have been possible without the volcanoes. These giants dominate the majestic landscape of Java, Sumatra, and many of the minor islands. There are few scenes as beautiful as the Sand Sea, with the ominous-looking Bromo crater on one of its sides and the typical outline of the Smeroe, the highest mountain in Java, in the background.

Beyond a doubt, the mysterious subterranean forces have always been a source of great interest to the local population. They dreaded the terrific phenomena — the earthquakes, the showers of ash, the mudstreams, the hot clouds, the lava flows. They prayed to Allah for the protection of their lives and property. They learned to interpret the significance of the mountain's activity; they became familiar with the sulphur emanations, the steaming wells, the fuming lakes, and the hundreds of other signs of volcanic life. The village elders knew how to predict the volcano's behavior; they passed their knowledge on to the younger generation. They were the first interested observers, the forerunners of the present volcanologists. They preceded the trained scientists, the well-equipped students of the modern decennia.

Scant and not very reliable data concerning the volcanic activities in Java prior to the sixteenth century have been compiled. It is known that in those days the country suffered from outbursts of the same volcanoes that have devastated it in recent times. After the European colonists — Spaniards, Portuguese, and Dutchmen — reached the archipelago, information, and that of a more reliable character, increased until in our time a well organized Government Volcanological Survey has taken up the scientific study of the volcanoes and is watching the dangerous ones.

A most disastrous event was the immediate cause of the institution of this Survey. On May 20, 1919, the contents of the Kloed crater lake, estimated at about ten billion gallons of water, were suddenly thrown out over the wall, mainly onto the southwestern slopes. Absorbing on its way the large quantity of loose material accumulated in the course of many years, it formed a tremendous flow of mud and rock which, moving with great velocity, reached the surrounding

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

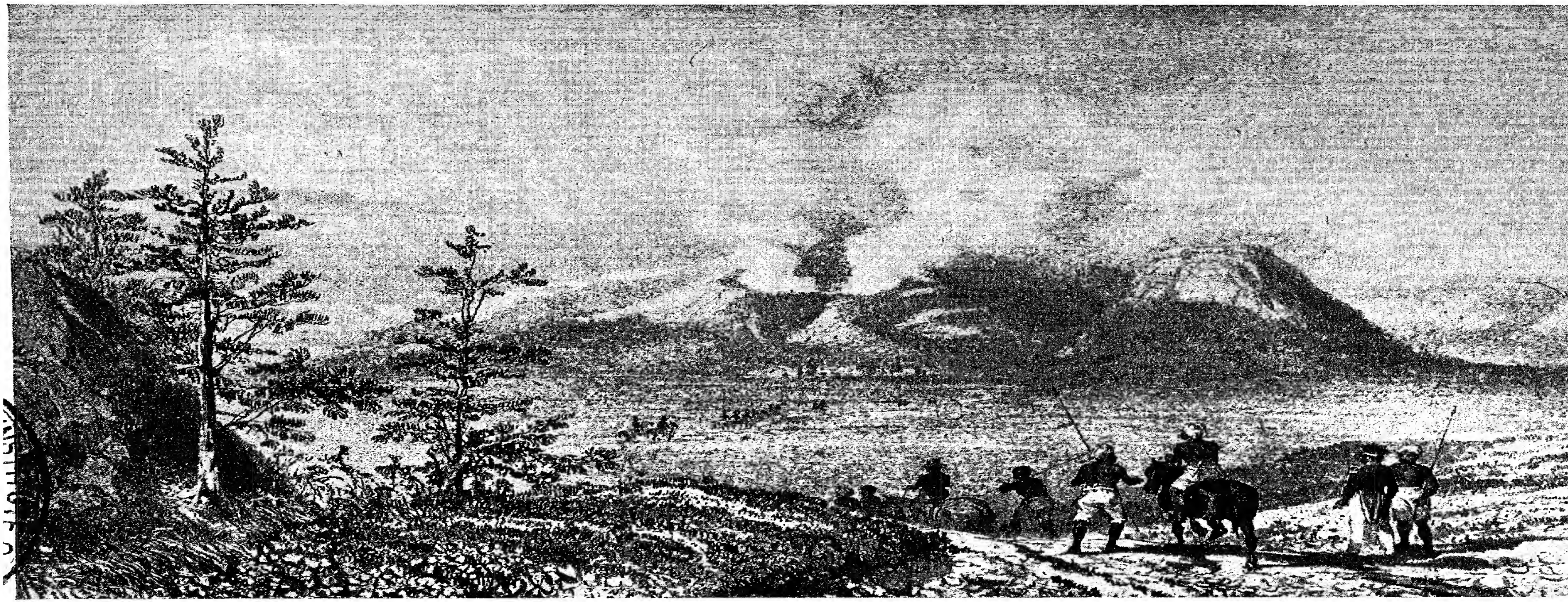


FIGURE 11. — THE BROMO, AFTER AN OLD FRENCH PRINT: "Volcan du Broumo dans les Montagnes de Mallang," Journal de la Navigation autour du globe de la Frégate la Thétis et de la Corvette l'Espérance . . . par . . . DE BOUGAINVILLE (1837).

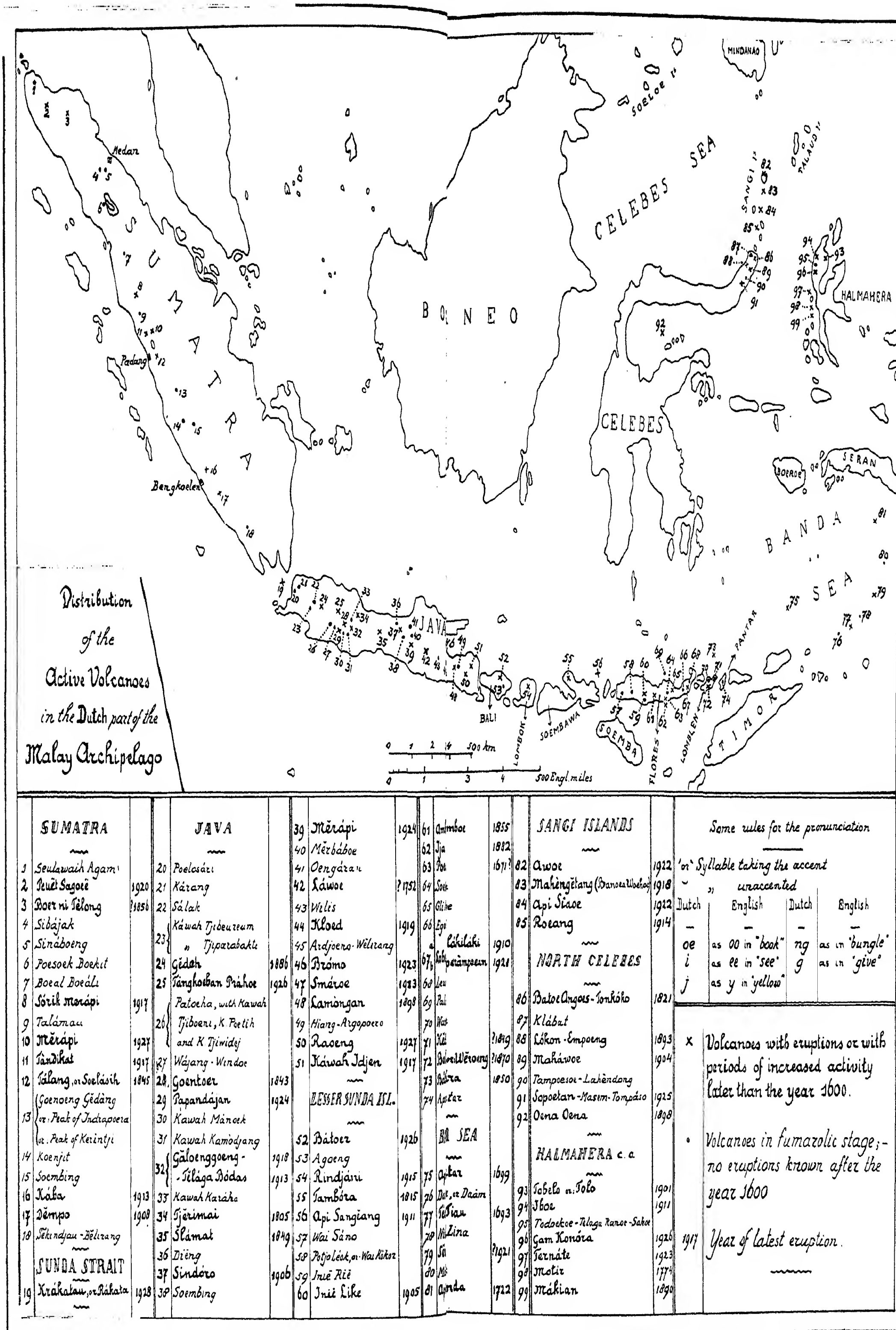



FIGURE 12. — ACTIVE VOLCANOES IN THE NETHERLANDS INDIES (1929), *from* N. WING EASTON'S "Volcanic Science in Past and Present" (*in* "Science in the Netherlands East Indies"). — *See also* the "Orientation map" (Figure 20) on p. 37. — WING EASTON'S map shows the year of the latest eruption. Since the publication of this map several new eruptions have of course taken place; under the present circumstances it is, however, not possible to bring the list up-to-date.

plains in a very short time, devastated the town of Blitar and several villages, and caused the death of 550 people. It was a repetition of an earlier disaster when a large flow of mud from the Smeroe volcano destroyed the town of Loemadjang.

Only shortly after this Kloed eruption in 1919, the Survey was instituted as a part of the Netherlands Indies Bureau of Mines. Dr. G. L. L. KEMMERLING was its first chief. During the twenty-two years of its existence, or until the occupation of the Indies by the Japanese, the Survey lived up to the importance of the task laid out for it. Volcanic life was studied thoroughly throughout the Indies; useful observations of many kinds were made; engineering works were planned and afterwards executed for the safety of the population; and a constant watch was held over the treacherous individuals in the volcanic family.

Many reports on volcanic activity have been written, and numerous publications on this subject have been put out during the last twenty-two years. KEMMERLING, TAVERNE, NEUMANN VAN PADANG, ESCHER, VAN ES, and STEHN have been the principal authors of books and articles. WING EASTON has given a number of valuable summaries of what has been achieved. Many of these studies have been published in the trimonthly bulletin of the Netherlands East Indies Volcanological Survey, issued in Bandoeng, Java, by the Government Bureau of Mines. The present article will condense some of these findings.

The work done by the Volcanological Survey is varied. Primarily, the Survey collects detailed information on volcanologic phenomena, using it as fundamental material for a thorough study of volcanic activity. There is hardly another field of science where the need for accurate data is comparable to the difficulty of experimentation. A volcanologist has to travel a long and hard road before he reaches his goal. He must not shrink from observing volcanic phenomena on the spot, often with real danger to his life. His task is to observe, measure, compare the variable signs of active volcanic life, and detect the laws which govern it. Occasionally, however, he is asked to make actual use of his experience and knowledge in telling civil service officials which quick measures to take in order to protect the local population from the threatening dangers. In exceptional cases he is called upon to assist engineers in designing daring projects for the more permanent protection of life and property.

Looking at a map of the Malay archipelago, one detects three bow-shaped lines of volcanoes:

*a.* a long and practically unbroken row extends from North Sumatra over Java and the lesser Soenda islands to the Banda archipelago;
*b.* a second, but short range is found in Halmaheira and the adjacent islands;
*c.* a third line of volcanoes, beginning in North Celebes, extends over the Sangir islands into Mindanao.

In South Celebes, there is a cluster of extinct volcanoes which have no connection with other groups. The map accompanying this article shows clearly how the ninety-nine active volcanoes in the Netherlands East Indies are distributed.

This distribution is closely related to the tectonic structure of the entire region. It is evident that the young and active volcanoes are confined to the unstable area of the latest geological period. The junction of the circumpacific zone with the Mediterranean and South Asiatic mountain ranges of the Tertiary Age has made the Indonesian archipelago a weak spot in the earth's crust, where the possibility of volcanic activity is imminent. It is, however, important to observe that there is an outer row of islands — Soembawa and Timor — where the magma has not broken through during the recent period of mountain building, and that there is an inner row of islands which show many signs of volcanic life. BROUWER, who has made a thorough study of this tectonic and volcanic relationship, explains the phenomenon by assuming two geanticlines in the southeastern archipelago, which show, with regard to the Australian continental mass, the same characteristics as the successive folds of the experiments on mountain-building, with regard to the moving resistant body. The overthrusting folds near the stable Australian submarine bank have developed an increased thickness of the crust which has a greater resistance to ascending magma. The simpler tectonic structure of the inner row of islands facilitated the creation of an outlet for the magmatic pressure.

It would be utterly impossible for the Service permanently to observe all volcanoes known to be active. Only those which are very active and which menace populated districts receive constant attention from the trained observers belonging to the Survey's personnel. Restricted funds and a consequently limited staff make it impossible to include as highly eruptive a volcano such as the Doekono in the program of uninterrupted observation. In its isolated location in Halmaheira no habitated places or other economic values are threatened by its numerous ash showers and lava flows. Occasional excursions are made to such live individuals. A considerable number of volcanoes in densely populated Java or in adjacent islands, however, are subject to continuous or semi-continuous control.

Of outstanding significance to the scientific world at large during recent years has been the activity of Krakatau, located in the Soenda Straits, between Java and Sumatra. It has been carefully studied by the Survey. Everyone knows that Krakatau startled the world by its phenomenal eruption in 1883. In May of that year, the first phase of eruptive activity was reported. Eruption continued with short pauses during the following months. In August it culminated in the disappearance of the Perwoebatan and Danan volcanoes and in the destruction of the basaltic Krakatau volcano. An immense underwater caldera was formed, and the southern half of the mighty cone with its bare perpendicular wall was left as a somber monument to one of nature's most destructive calamities. More than 30,000 people lost their lives and extensive damage was caused.

For more than forty years Krakatau was thought to be extinct. Scientists were greatly interested in watching how an island which has been completely robbed of its vegetation and its animal life was furnished with a new flora and fauna. Their studies and conclusions have been published with the volcanological observations. Interest was again kindled when, two days before the close of 1927, old Krakatau showed new life. Submarine activity was observed first. Gradually, out of basaltic bombs, ashes, and old

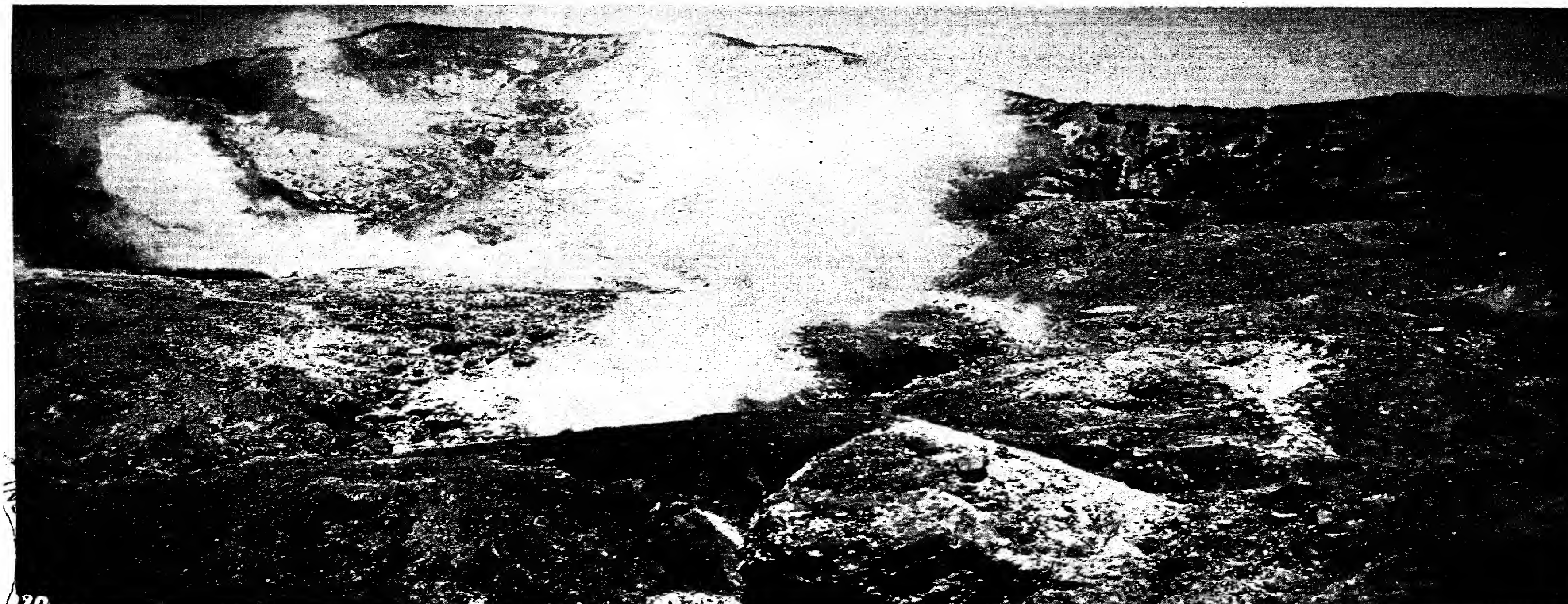


FIGURE 13. — SOLFATARA NEAR THE TOP OF MOUNT PAPANDAYAN (West Java). — *Courtesy Netherlands Information Bureau, New York City.*

material, there was built a volcanic cone which appeared above the surface on January 26, 1928. It was submerged again by surf action, but a year later it reappeared; it is still there. "Anak Krakatau," the child of Krakatau, was born.

From the first birth-pangs until it was thirteen, the baby volcano has been closely watched by the experts of the Volcanological Survey. Every detail of its activity has been observed and recorded. Numerous excursions have been made, first to near-by Verlaten-eiland at a distance of relative safety; later, between eruptions and not without personal risks, to the active cone itself. A number of times the island has been carefully surveyed and mapped and the constant change of its topography registered in detail. Neptune tried to reclaim part of his lost territory by attacking the new shore line; he succeeded temporarily in breaking the crater wall. Shortly afterwards the then crescent-shaped island changed its appearance again; new outbursts of bombs and ashes closed the gap, and the crater lagoon became a crater lake.

Accurate soundings and astronomical bearings have disclosed that Anak Krakatau lies about midway between the former craters of the Perboewatan and Danan volcanoes, which disappeared in 1883, and that it is situated near the rim of the gargantuan caldera which resulted from the catastrophic collapse of this volcanic group.

When Anak Krakatau was being built, the eruption products of the countless explosions went high into the air. Water and bombs were thrown to heights of 4,000 feet and more. During this submarine action the huge fountains of water formed a fantastic display. Later, when Anak Krakatau had risen from the deep and had become an island, the eruptions were characterized by black columns of ejected material, ashes, and bombs. Most of these fell into the sea and were carried away by the heavy current; however, even the larger bombs floated until they lost their gas content. On only one occasion was a flow of lava observed during the submarine stage; at least the water was illuminated from below, an effect which was strongest near the crater. Numerous other features which have greatly contributed to man's knowledge of the mysterious and ominous forces of nature's underworld have been observed, studied, and recorded.

But Anak Krakatau, though very spectacular, has been only one of many subjects of study. The Netherlands Indies Volcanological Survey, during the twenty-two years of its existence, never ran short of material for observation. One feature, which was given an important place, and for good reasons, is the rise and behavior of lava plugs inside volcanic craters. The phenomenon has been minutely studied in the Merapi crater, a unique example of plugs. However, the same feature has been observed in many other cases, and it appears not to be exceptional. On the contrary, it is a rather natural development. A plug is the result of the slow rise of a tough mass of molten lava through a narrow crater passage. Its surface consists of a shell of solid material, cracked, by cooling, into cohesive blocks. The hot and viscously fluid inner part occasionally bursts through the outer carapace and flows out, either into the crater bowl or, in case the plug bulges over the rim, along the slope of the volcano. Its viscous character does not allow it to descend far, but parts of these lava-tongues often snap off and cause the much-dreaded avalanches and the accompanying hot gas and ash clouds.

Except for that part of the survey which is more or less pronouncedly morphological and structural, the studies mainly concern features which are indirectly connected with the magma and for that reason are mostly physical, chemical, seismical, hydraulical or meteorological. These are the particular volcanic phenomena which have been responsible for numerous disasters. Consequently, the Survey has spent much time and energy observing these phenomena, interpreting them, and trying to find the means of preventing catastrophies. Two phenomena have been exceptionally important: mudstreams or "lahars," and hot ash and sand clouds or "ladoes." They have been the cause of many casualties and of extensive material damage in Java and elsewhere.

Two active volcanoes in central Java have demonstrated these significant features: the Kloed, which has an unfavorable reputation for its destructive mudstreams, and the Merapi, hot ash clouds from which have annihilated many a life. In recent years these two volcanoes have been excellent fields of study, although the same phenomena have been observed on many other volcanoes.

The hot ash clouds, well-known from Mont Pelée in Martinique under the name of "nuées ardentes" and studied by A. LACROIX, received particular attention during the eruption of Merapi in 1930–1931. The Merapi studies have revealed that these ash clouds or "ladoes," as they are locally called, are masses of rapidly expanding superheated steam and other gases which, by their intensive turbulence, are able to carry a mixture of coarse and fine material far into the lower country. It is of great importance for the future protection of the people living on its slopes to know whether the catastrophic results of the "ladoes" in those years were caused by a primary direction of downward slanting eruptions, as, according to LACROIX, was the case with the "nuées ardentes" of Mont Pelée in 1902, or whether the destruction came from the gases escaping from the descending masses of hot material. In the former case the northwest, west, southwest and south slopes of the volcano would be unsafe for a distance of approximately six miles from the top. In the latter case the course of deep ravines and the existence of high ridges could be a great protection.

During the eruptive phases of 1930 and 1931 many "ladoes" were observed by a number of trained volcanologists. Their findings have been discussed by ESCHER, KEMMERLING, GRANDJEAN, LACROIX, and NEUMANN VAN PADANG. Although the writers on the subject do not concur completely in their opinions, it seems probable that both types of clouds played a rôle in the destructive activity of the Merapi during these months. During the Merapi eruption, GRANDJEAN observed the "nuée ardente d'explosion dirigé," the prototype of which caused the Martinique disaster, and described it in detail. He saw several "flashes," originating from the lava at the top, directed downwards and consisting of gas shots, rapidly expanding into voluminous clouds. In his opinion the gas pressure within the viscous prop of lava which was pressed from the crater became so great that the lava exploded at its weakest point and gave birth to a flashing

FIGURE 14. — THE ISLAND OF KRAKATAU. — *Courtesy Royal Dutch Airlines.*

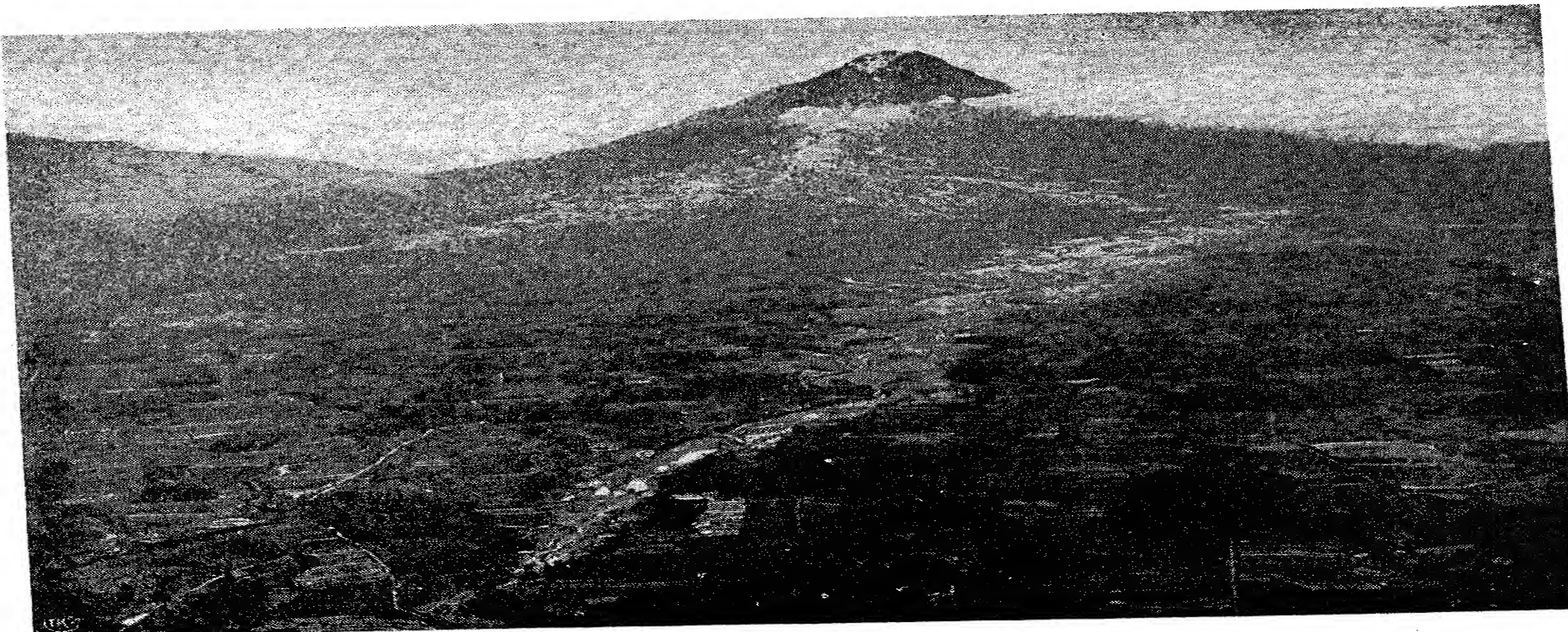


FIGURE 15. — MOUNT MERAPI AND THE DESTRUCTION BY LADOES (LIGHT AREAS) IN DECEMBER 1930. (*From Vulkanol. Meded.*, Vol 12.)

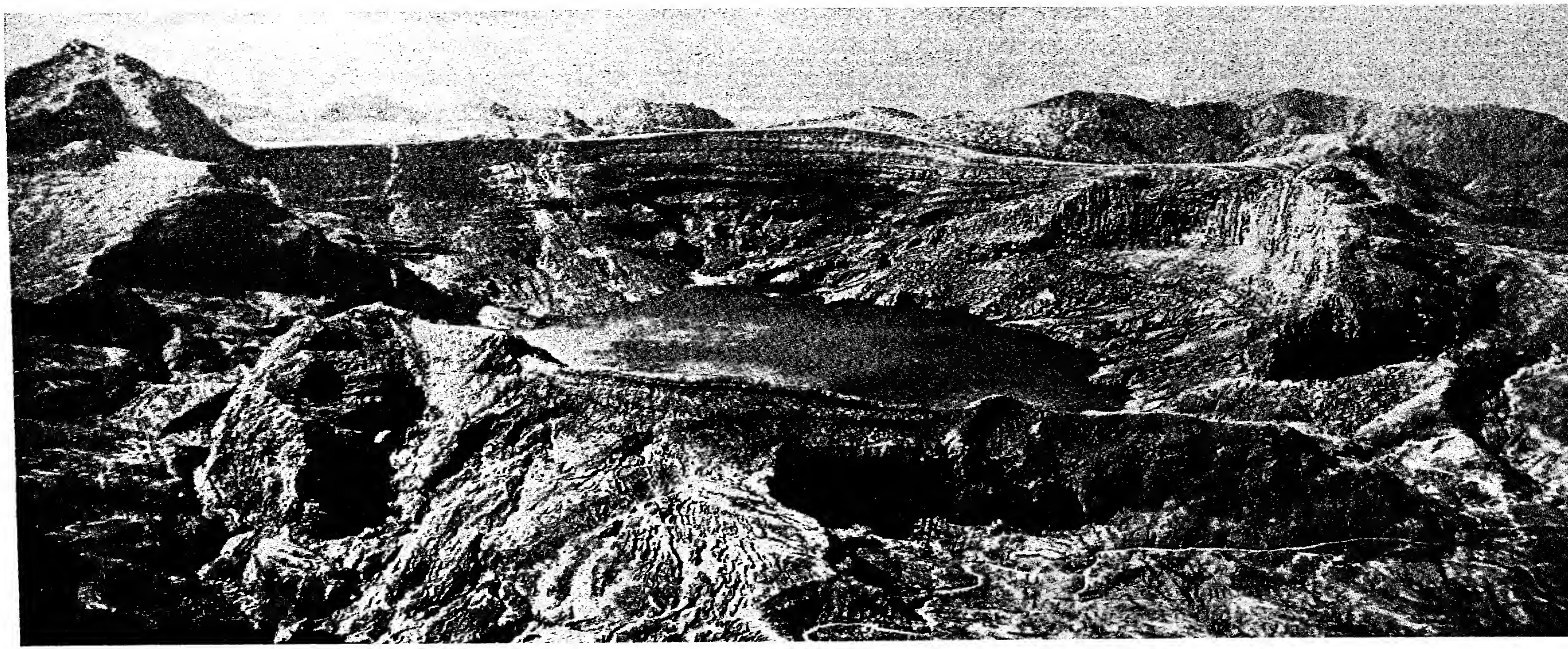


FIGURE 16. — THE CRATER LAKE OF THE KLOET VOLCANO. A tunnel has been constructed to carry the water away as soon as it rises above a certain level. (*From* "Java seen from the Air".)

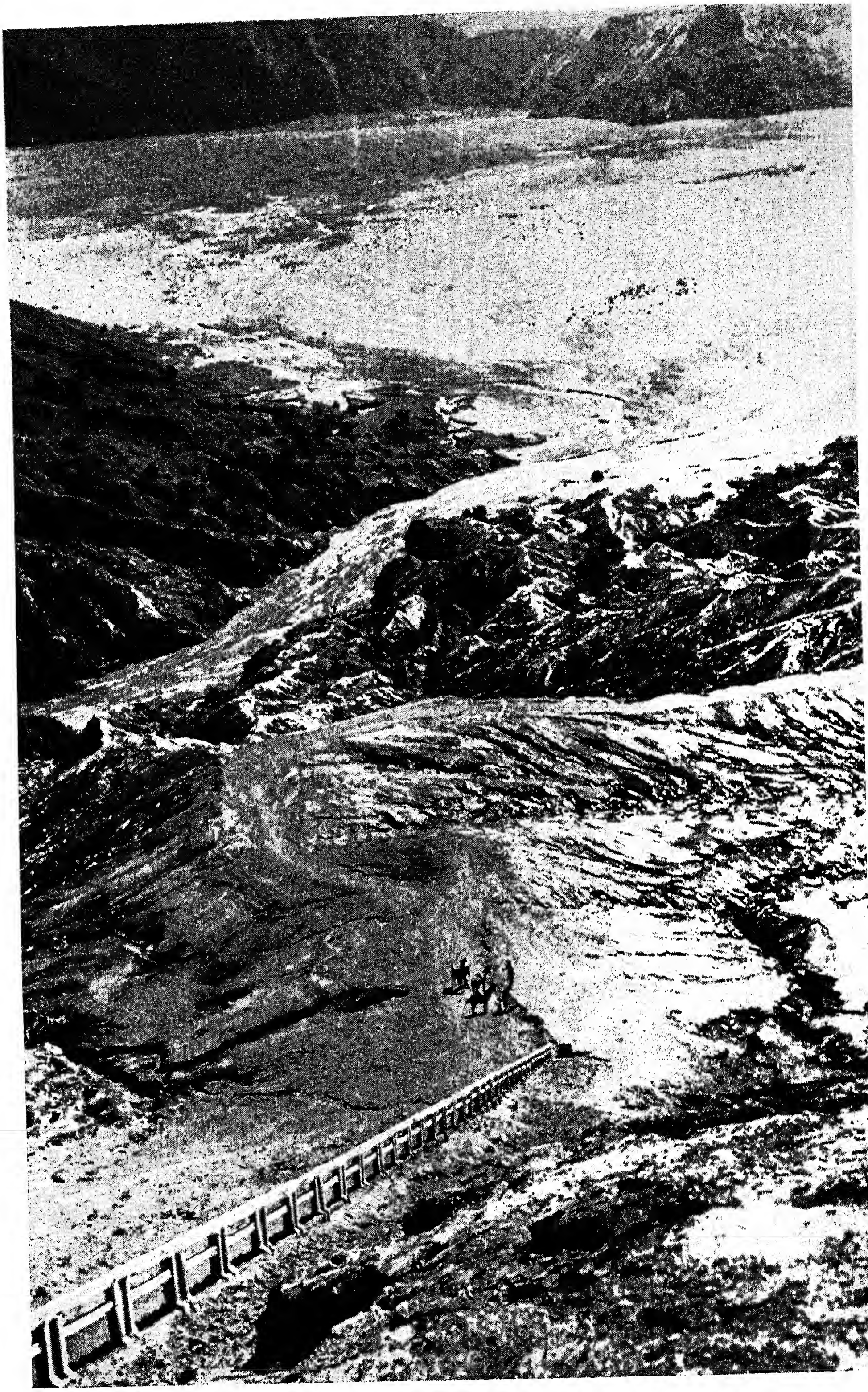


FIGURE 17. — THE BROMO CRATER. — *Courtesy Netherlands Information Bureau, New York City.*

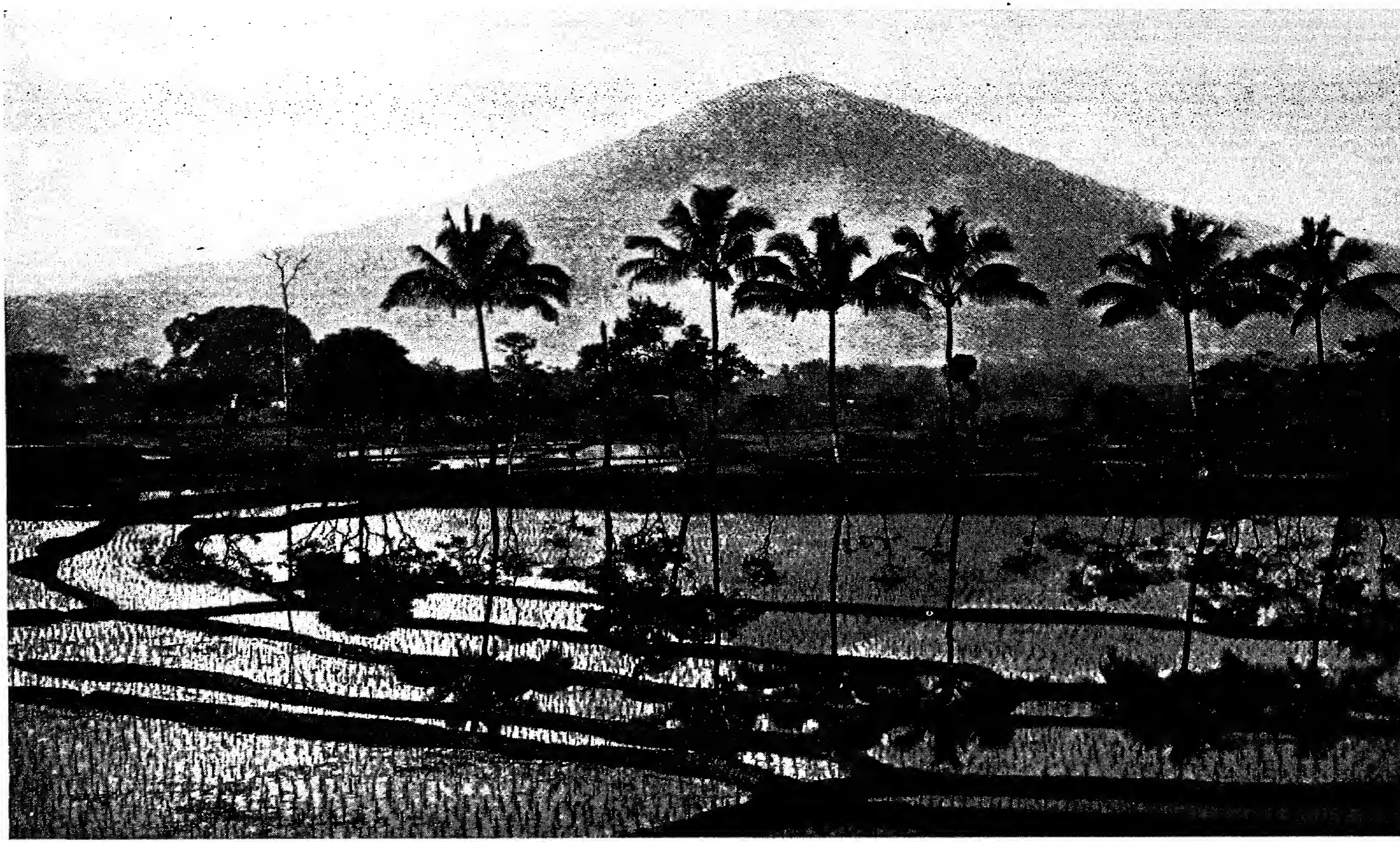


FIGURE 18. — MOUNT TJIKOERAJ (2818 *m.*), WITH RICEFIELDS ("SAWAHS") IN THE FOREGROUND, A TYPICAL JAVANESE SCENE. — *Courtesy Netherlands Information Bureau, New York City.*

beam of gas which carried parts of the blasted lava.

There seems to be sufficient evidence, however, that numerous "nuées ardentes d'avalanche" have caused much more damage than the cloud-type just described. They are the gas bursts from lava fragments crushed on their way downward. NEUMANN VAN PADANG tells of a thundering flow of hot stones and sand which he saw descending a steep ravine close to the observation post of the Survey at Maron. No "nuée ardente," no hot flow of gases preceded this avalanche, but a cloud of sand and ashes lagged approximately a mile and a half behind it. He also records the important fact that most of the damage was found near and on both banks of the deep gullies, especially where these gullies changed their course. The ash clouds did not follow the curves but continued at each bend in the original direction.

NEUMANN VAN PADANG observed that explosions in the mass of lava caused the formation of clouds of pine-tree shape and the ejection of lava fragments which descended at great speed ahead of the cloud. A flow of red-whitish material from the explosion point followed, accompanied by white and dark brown balls of vapors which rotated in different directions. This mass of dust and gas, resembling an emulsion, travelled downslope at an estimated velocity of 250 feet per second. After the cloud had cleared away, its path was littered with white dust and several pieces of rock. Loud rumbling was heard preceding these "ladoes."

Analyses of gas samples taken from the hot "ladoe" material have revealed an unexpectedly high percentage of carbonyl sulphide in these gases. Some samples contained more than three per cent of this unusual compound. It is assumed that partly charred timber and sulphur present in the volcanic products could combine at the existing temperatures. Since the minimum formation temperature of carbonyl sulphide is 400° centigrade, and trees were not completely charred or burned, it is estimated that the temperature of the "ladoe" had been approximately 450° centigrade. This gas may have been the cause of the numerous explosions which occurred.

The accompanying photograph shows clearly the course of the destructive avalanches and the scorched path of the hot clouds. Thirteen villages were entirely destroyed and twenty-three were seriously damaged. More than 1350 lives were lost; approximately 2100 animals were killed.

It has been a great disappointment to the personnel of the Volcanological Survey that so serious a loss of life could not have been prevented, especially since Mount Merapi is the only volcano of its kind where an eruption has followed years of regular observations. Its observers were at their post on the slope of the volcano. They showed great courage and did what was humanly possible to warn the authorities and population of the forthcoming dangers. A number of macrotremors registered on the seismograph had indicated the possibility of an eruption. Contrary to the current ideas among volcanologists, the eruption did not at once set in at full strength; the catastrophical eruptive phase came later. The lava of Mount Merapi at first came slowly out of the mountainside and flowed downward. Part of it was a stream; part of it crumbled off and was destroyed by small local explosions. Twenty-three days after the magma had made its appearance, the first ash cloud came rushing down one of the ravines and extended a distance of five miles. The next day the catastrophic "nuée ardente" came down and reached the enormous length of seven and a half miles.

Generation upon generation of laborious Javanese have plowed, planted, and harvested the fertile rice fields on Mount Merapi's slopes. Their acquiescent attitude towards acts from Above makes them accept the tragic reality of volcanic danger more easily than Western people do. They are also sceptical about the wisdom of Western science and ingenuity and are difficult to convince that an early evacuation of their beloved villages and abandonment of a few personal belongings, are the wisest things they can do under the circumstances. As soon as the danger has passed, there is hardly anybody who can prevent them from returning to the danger zone and from repairing the damage to home and field.

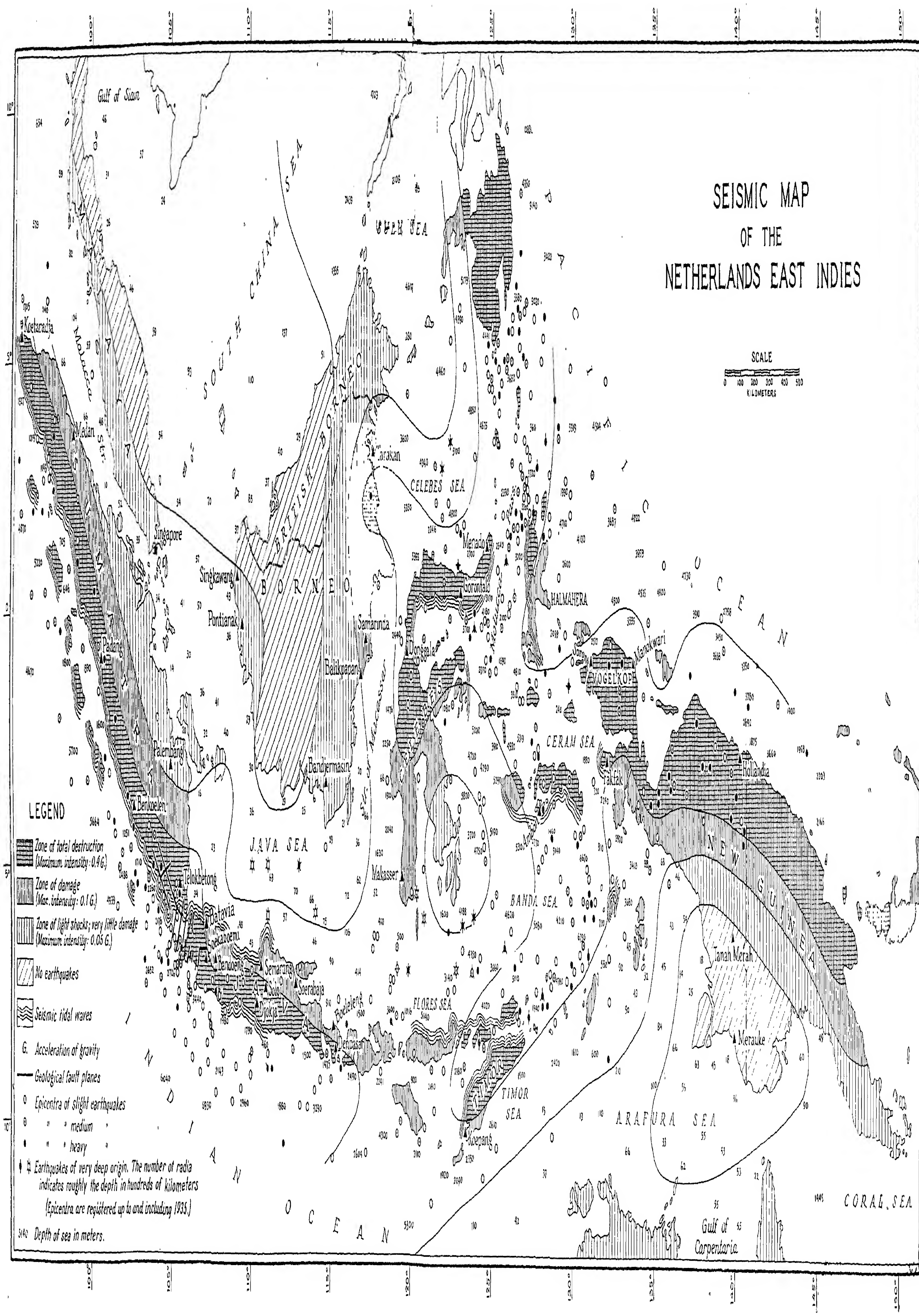
Nevertheless, in 1934 many villagers showed that they had learned their lesson by obeying when they were ordered to leave. In one case it was in the very nick of time, for twenty minutes later the singeing ash cloud rushed through the "dessa" and nothing but scorched earth was left. This event certainly should have given the population some faith in the preventive measures of the Volcanological Survey. This faith will undoubtedly facilitate the Survey's task in the future. However, the trickiness of the volcano may annul the now existing but still feeble confidence in the predictions of the volcanologists.

Dr. KEMMERLING has given a very detailed description of the "lahars" which have been so terribly destructive during and after the 1919 eruption of the Kloed. He has clearly pointed out that these "lahars" are of two types: the eruption type or hot "lahars" and the common type or cold "lahars."

The history of Mount Kloed's active life has revealed that the crater lake has been thrown out at each eruption. Through all ravines originating near the crater, great masses of hot mud and sand descended into the fertile lowlands, although the volume of these masses varied greatly. It has been shown, however, that the combined effect of the repeatedly occurring cold "lahars," which used to wash the accumulated loose material down along the slopes of the volcano with every heavy rainstorm, has been more serious than that of the occasional hot ones. Particularly during the first years following a new eruption the tonnage of material which is transported to the plains surrounding the volcano is enormous.

It should be borne in mind that the "lahar" phenomenon is genetically connected with the strato-type of volcano, which consists partly of loose volcanic products easily eroded by the heavy tropical rains. It is further obvious that a scarcity of vegetation promotes the formation of "lahars." Consequently, the danger of cold "lahars" increases immediately after each eruption, since part of the vegetable life on the volcano's slopes will have been destroyed.

As KEMMERLING pointed out, it depends greatly upon the amount of water inside the crater at the time of the eruption, whether a real mud stream will flow down the mountain's slopes or


SEISMIC MAP
OF THE
NETHERLANDS EAST INDIES
SCALE
0 100 200 300 400 500
KILOMETERS
LEGEND
Zone of total destruction (Maximum intensity: 0.4 G.)
Zone of damage (Max. intensity: 0.1 G.)
Zone of light shocks; very little damage (Maximum intensity: 0.05 G.)
No earthquakes
Seismic tidal waves
G. Acceleration of gravity
Geological fault planes
Epicentra of slight earthquakes
" " medium "
" " heavy "
Earthquakes of very deep origin. The number of radia indicates roughly the depth in hundreds of kilometers
(Epicentra are registered up to and including 1935.)
3140 Depth of sea in meters.
Gulf of Siam
SOUTH CHINA SEA
SULU SEA
CELEBES SEA
PACIFIC OCEAN
JAVA SEA
FLORES SEA
BANDA SEA
CERAM SEA
TIMOR SEA
ARAFURA SEA
CORAL SEA
INDIAN OCEAN
Gulf of Carpentaria
Malacca Str.
BRITISH BORNEO
BORNEO
NEW GUINEA
HALMAHERA
VOGELKOP
Koetaradja
Medan
Singapore
Padang
Palembang
Benkoelen
Telokbetong
Batavia
Soekaboemi
Bandoeng
Semarang
Solo
Djokja
Soerabaja
Boeleleng
Denpasar
Singkawang
Pontianak
Bandjermasin
Balikpapan
Samarinda
Tarakan
Donggala
Makasser
Menado
Gorontalo
Sorong
Manokwari
Fakfak
Hollandia
Tanah Merah
Merauke
Koepang

whether an ash cloud will result from the volcano's activity, or perhaps both phenomena occur. The upper layers of water in the crater will be thrown out without a sufficient rise of temperature to cause a rapid evaporation of this water. At the bottom of the crater, however, this water will be heated and transformed into steam, with the result that the freshly ejected material will form a cloud of ashes or a "nuée ardente." The latter will not have the devastating effect of the Merapi clouds previously described, because the Kloed crater is wide and has no plug bulging over the wall. This bulging plug is typical of the Merapi and essential for the formation of lava avalanches and their accompanying "ladoes."

This important fact has made the authorities decide to take steps permanently to drain the Kloed's crater lake. A difficult task was laid on the shoulders of those who had to carry out this seemingly fantastic idea, which included the drilling of a system of tunnels through the side of this active volcano. Many difficulties had to be overcome, but the staff of the Government Bureau of Mines succeeded. Ever since the completion of this job the crater lake of Mount Kloed has been of minor dimensions. A future eruption will prove whether the population has benefited from this coöperation of volcanologist and engineer.

The Japanese invasion has interrupted this important scientific work, which was of great practical significance. But the time will come when Dutch and Indonesian volcanologists mount again their remote and often dangerous observation posts and continue their task for the benefit of this beautiful tropical country, its population, and the world at large.

# EARTHQUAKES IN THE NETHERLANDS INDIES

*by* Lieutenant Colonel C. P. BREST VAN KEMPEN, Eng. (Delft) *

*R. Neth. Indies Army Engineers*

*translated by* H. STAUFFER, Ph.D.

*Research Associate in Geology, Stanford University, California*

— WITH A FOLDING MAP —

Three types of earthquakes can be distinguished: those caused first by structural movements, second by violent eruptions of volcanoes, and third by the collapse of abandoned mines and subterranean caves. Tectonic and volcanic earthquakes are nearly exclusively restricted to geosynclinal areas, where at present the earth crust is in the process of folding, faulting, rising, or subsiding. Such a region is represented by parts of the Netherlands East Indies, where the Alpine-Himalayan geosyncline merges into the circum-pacific moving belt.

The following lines present some earthquake problems in the seismic regions of the N.E.I. and their relation to its inhabitants.

It is obvious that the buildings in those regions must be constructed in such a way as to withstand the effect of severe shocks in order to avoid loss of life and property. Architects and engineers require accurate information on the movement of the ground during previous earthquakes. This information consists mainly of the maximum acceleration, the amplitude, and the period of the movements.

The maximum acceleration or intensity of the expected movement of the earth's crust is indicated on the attached map (Fig. 19) by zones of different intensity. This map has been compiled by Dr. H P. BERLAGE, scientific collaborator of the Royal Magnetic and Meteorological Observatory in Batavia and the writer. The files of the observatory supplied abundant information regarding earthquakes in the N.E.I. during the last 250 years.

The locations of the epicentra, depth of origin, and depth of seabottom have been taken from maps 3 and 5 of the "Atlas van Tropisch Nederland" published in 1938 by the Royal Netherlands Geographical Society in coöperation with the Topographical Service of the N.E.I.

The inhabited places are shown on the map by small black squares to differentiate them from the black circles which indicate the locations of the epicentra of the heavy earthquakes. The zones of intensity are shown graphically by different patterns with the maximum intensity of movement to be expected. It must be remembered that the area of maximum movement of an earthquake is very small compared to the total surface where the movement can be observed.

The coastal areas where seismic tidal waves can be expected are also shown on the map.

As indicated by the map the geosynclinal ocean-bottom along the west coast of Sumatra, south coast of Java and Lesser Soenda Islands reaches a maximum depth of 7000 meters, while on those islands steep and high mountains occur, such as the Barisan in Sumatra and mountains along the whole length of Java. In such a deep sea and high coastal area the map shows a maximum of epicentra; the most destructive earthquakes occur here.

In the area of the Banda Sea, structural movements of the earth's crust have resulted in the forming of a structural graben, whereby this small water body reaches a maximum depth of 7000 meters. Consequently, the islands in this region, Alor, Wetar, Leti, Babar, Tanimbar, Kai, Ceram, Ambon, and Boeroe, are centers of seismic activity. Especially the three last-named islands are often subjected to violent earthquakes. In addition, frequent destructive earthquakes have been recorded from North Celebes, including the whole northern peninsula and a large portion of central Celebes. Furthermore, the northern-most

* The following article is a translation of an account published in the *Natuurwet. Tijdschrift voor Ned. Indië* 102, 1 (January 1942). Dr. H. STAUFFER, who kindly prepared the translation and supervised the redrawing (with an English text) of the map accompanying this account, has greatly reduced the first part of the original article as this deals with earthquakes in general. The parts referring to the Netherlands Indies are, however, given in full.

peninsula of Halmaheira and the northern part of New Guinea also belong to the most active seismic regions in the N.E.I. To the north of Celebes extends the Celebes Sea, 4800 meters deep at a distance of 100 kilometers from the coast. Some mountain ranges in New Guinea are over 4000 meters high, while to the north, only 15 kilometers from the Vogelkop and Tanah Merah Bay the Pacific Ocean reaches a depth of 2000 meters, which increases to 4000 meters near the equator.

Along the east coast of the Peninsula of Malakka, in the residency of Dutch West Borneo, in British North Borneo, and in southern New Guinea are large areas free from earthquakes. Presumably those areas were folded and uplifted from the early geosynclinal sea in older geological periods, but are at present structurally and seismically inactive.

In using this map it should be remembered that the zones of intensity are bounded by lines, but actually those zones merge gradually into each other. As a matter of fact, there are transition zones estimated 40 to 50 kilometers wide and the axes of these zones would be represented by the boundary lines of our map.

The maximum horizontal accelerations as shown on the map were calculated by using the deduction of intensity grades according to the scale of Cancani or Rossi-Forel to values for horizontal accelerations. The accuracy of the results according to this deduction is only approximate, as use can only be made of rather incomplete data. (For further details I refer to "De Ingenieur in Ned. Ind. 1939, no. 9, p. 1204"). Consequently the attached seismic map can only be considered as a preliminary one.

The accurate information about the movement of the ground which the engineer must have in order to plan his buildings and other constructions is obtained by instruments none of which are as yet used in the N.E.I. In other countries with frequent earthquakes such as Japan and California, those instruments have already been in operation for about ten years.

The few seismographs in the Netherlands Indies Archipelago are very sensitive for microseismic movements, but useless for recording violent earth shocks with near epicentra. In this case the needles are thrown outside the revolving cylinders and the registration of the earthquake becomes impossible.

It is imperative that in the densely-populated areas of the N.E.I. a number of seismographic stations should be constructed, where destructive shocks also can be recorded. Each station should be provided with three seismographs, orientated N–S, E–W, and vertical in order to register the amplitude and periods of the movements. Further, an accelerometric seismograph is required to record the maximum acceleration. All instruments should be constructed in such a way that even during heavy earthquakes they will continue to function normally.

# DIVERSITY AND UNITY IN SOUTHEAST ASIA

*by*

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The first half of the 1940's may prove to be the most momentous period in the history of Southeast Asia. At the beginning of this decade the lands between China, India, and Australia were, with the exception of the buffer state Thailand, under the direct control of Western nations. Then, in a few months, the 150 million inhabitants of this region were brought under the rule of Japan. Will the expulsion of the Japanese mean a full turn of the wheel of fortune, a return to the situation of 1940? Obviously not; the war has brought such changes in economic, cultural, and political relations and mental attitudes, in the East as well as in the West, that a return to the *status quo* of prewar years is not only undesirable but impossible.

The colonial question is therefore of greater importance than ever. It is perhaps to be expected that the discussions should center on the subject of political independence, but it is unfortunate that this topic proves so absorbing that little attention is being devoted to equally important economic and social issues. The anticolonial tradition in American history naturally expresses itself in a strong emotional protest against the existence of dependent areas. This attitude can be a powerful lever for progress if it is understood that we are dealing here not with a fortuitous and immoral political relationship but with a deep-rooted cultural and economic complex. The colonial relation is essentially one form of the acculturation process, and as such it is a transitory phase. It was as a dependency of Rome that Western Europe was "exploited," but also enriched, by the more advanced Mediterranean civilization. In time it threw off the Roman yoke, and eventually it surpassed the old Empire.

Southeast Asia is now in the stage of "imperial devolution." The preoccupation with the political aspect of this process obscures, however, the problem in its totality. If one looks at Thailand or at some of the republics of tropical America, it is plain that for the masses a higher standard of living and more democratic procedures do not automatically result from political sovereignty. The Philippine commonwealth, while moving rapidly to political independence, has remained economically dependent on the United States. In the other parts of Southeast Asia prosperity was not based so overwhelmingly on the right of free access to one market, but collectively these lands

* Reprinted, with kind permission, from the *Geographical Review* 34:175–195 (1944). — The maps contained in this article are based on material collected for a research project on Southeast Asia financed by the Rockefeller Foundation and the Coolidge Foundation and sponsored by the American Council of the Institute of Pacific Relations. 

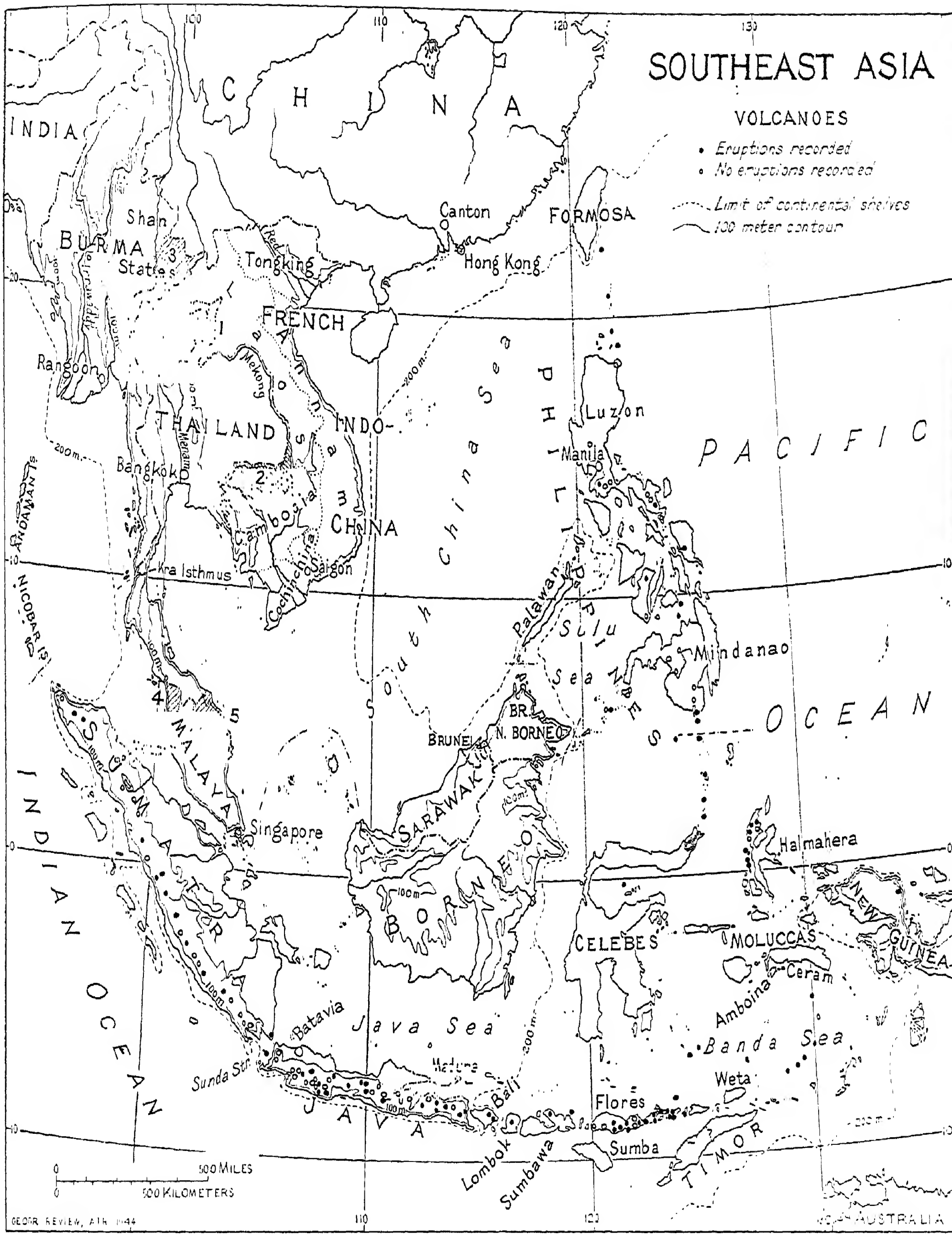


Figure 20.—Orientation map. The 100-meter contour line (omitted for the smaller islands) brings out the small extent of lowland areas in Southeast Asia. The 200-meter bathymetric line indicates the extent of the continental shelves. Tectonic movements in these shelves have subsided; the uplands are dominated by erosional activity, and relatively extensive coastal plains have resulted from deposition. In the zone between the Sunda shelf on the west and the Sahul shelf on the east, and continued to the north in the Philippines, recent and continuing vertical movements are reflected in the mountainous island chains, separated by deep sea basins. The distribution of volcanoes is based on W. D. Smith: The Philippine Islands (Handbuch der regionalen Geologie, No. 3). Heidelberg, 1910, pp. 13 ff. (map of Philippine Islands on p. 14); F. von Wolff: Der Vulkanismus, Vol. 2, Part 1. Stuttgart, 1923, pp. 159 ff. (Fig. 12 is an adaptation of W. D. Smith's map); Atlas van Tropisch Nederland, 1938, Sheet 5; L. M. R. Rutten: Voordrachten over de geologie van Nederlandsch Oost-Indië. Groningen, 1927. The large number of volcanoes in northern Celebes necessitated the use of smaller symbols in that area.—In March, 1941, the Japanese government, acting as "mediator" in the Thai-Indochinese war, allotted parts of Laos and Cambodia (1 and 2) to Thailand. The other boundary changes were announced by the Japanese radio early in July (*New York Times*, July 6, 1943). Parts of the Shan States, of which Kentung and Möng Pan were mentioned by name, were added to Thailand (3). Also, the four northern Malay States, Perlis and Kedah (4) and Kelantan and Trengganu (5), were "ceded" to Thailand.

were in the same position to the Western countries as the Philippines were to the United States. Japan granted "independence" generously all over Southeast Asia, but at the same time it insisted on a "co-prosperity sphere" in which, obviously, it would rule while the native peoples would remain the hewers of wood and drawers of water. In turn the Western nations have attempted to counteract Japanese propaganda strategy by also making political promises. Thus we may anticipate the strange phenomenon that after the defeat of Japan the ambition of the native peoples for political freedom will be stronger than ever but their economic dependence on the Western nations will be the same, if not greater, than before. This divergence of political ideals and economic realities will be the most baffling problem of postwar tropical Asia.

A one-sided approach, focusing on political doctrines, must inevitably lead to disillusionment. The peoples of the liberated countries will discover that independence has not diminished the need for markets, capital, and trained personnel and that it has not solved the problem of security. And the American people, once again, will be dismayed by the persistence of evils that were supposed to disappear when this war for freedom had been won.

It is often assumed that independent sovereignty for all peoples must be the ultimate aim of a just world order. Yet the Soviet Union, with its great variety of peoples, shows a markedly different, and apparently satisfactory, solution on the basis of equal partnership. We cannot a priori rule out the possibility that some peoples of Southeast Asia may prefer a similar interdependent relationship. However, whether the future is to be one of equal partnership or of independence, there must be a period of preparation before such adult status can be attained. The roads to this goal as well as the time required to reach it will differ for different peoples, depending as much on their social-economic structure as on their political cohesion.

These considerations are all too often forgotten in the oratorical demands for freedom now and everywhere. Modern means of communication have made the earth a unity, but they have not created uniformity. The recent discovery that the earth is "global" does not change the fact that peoples are first of all a part of their local culture pattern, each with its own interdependent relationships of man to man and man to nature, its own traditions, institutions, and ways of making a living. Terms such as "democracy," "self-determination," and "independence" receive their meaning from local experience, not from global charters. Instead of offering universal, ready-made schemes that are likely to prove misfits, we must analyze the specific regional problems and lay plans accordingly.

**Regional Diversity in Southeast Asia:** — In recent years various plans have been advanced to fuse the former dependencies into one or two political units administered or supervised by an international authority or mandatory power until the countries are ready for complete self-rule.[1] Quite aside from other difficulties, such schemes do not take sufficient account of the diversity of Southeast Asia.

The natural environment shows a great variety of conditions. The dominant fact is the fragmentation of the lowlands by either seas or mountains. Great plains at one time existed where we now find the drowned Sunda and Sahul shelves, but the present plains beyond the amphibious coastal swamps are relatively small. Within the lowlands there are strong contrasts in soil fertility.[2] The best soils are those derived from volcanic deposits. These are found along the inner curve of the great southern island arc, from Sumatra east to the "fishhook" around the Banda Sea, and in the northern arc (part of the East Asiatic island festoons) running from Formosa through the Philippine Islands south to northern Celebes and Halmahera (Fig. 20).

In contrast, British Malaya, Borneo, and western New Guinea are nonvolcanic; moreover, the heavy equatorial rains have thoroughly leached the soils, limiting the range of suitable crops and resulting in lower yields than in the volcanic lands (Fig. 21).

Burma, Thailand, and French Indochina have no active volcanoes, and their alluvial deposits are on the whole less rich than those of, say, Java; on the other hand, their soils are less leached than those of the equatorial zone.

Settlement, largely determined by the search for wet rice fields, reflects these differences. The population is highly concentrated on the alluvial plains, except those of New Guinea, Borneo, Sumatra, and Malaya, where swamps or leached soils prevail (Fig. 22). External forces have accentuated rather than smoothed out the contrasts. The Chinese arts of dike building and intensive farming have enlarged the carrying capacity of the Red River delta and the Annam coast; Java and Luzon, the most favored islands of Malaysia, have become centers of colonial development and have seen their populations increase tenfold since the beginning of the nineteenth century. In these three areas population pressure has reached the danger point. In Lower Tongking and Java the average density to a square mile is about 1000 people. In central Luzon it is 600, but unsatisfactory conditions of land tenure add to a pressure that otherwise would seem comparatively moderate.

There are signs, however, that the peak of concentration has been reached. The census figures of recent decades indicate — even if ample allowance is made for errors in enumeration — that the average annual rate of population growth has been much higher in certain sparsely populated areas than in the traditional cores (Fig. 23). This is not to say that the trend is toward an even distribution throughout the region; even a small absolute increase in numbers in an almost empty district will result in a substantial percentage of growth. It does mean, however, that the spread of modern civilization, in such forms as roads, hygiene, or development of resources, raises some potentially favorable areas to a higher level of opportunity, either for the local population or for immigrants. The high rate of increase

[1] See, for instance, "The United States in a New World, II: Pacific Relations." *Fortune*, Supplement, August, 1942; ELY CULBERTSON: Total Peace. Garden City, N. Y., 1943, especially pp. 323–334.

[2] E. C. J. MOHR: Climate and Soil in the Netherlands Indies. *Bull. Colonial Inst. of Amsterdam*, Vol. 1, 1937–1938, pp. 241–251; *idem:* De bodem der tropen in het algemeen, en die van Nederlandsch-Indië in het bijzonder, 2 vols. (in 6 parts). *Koninklijke Vereeniging "Koloniaal Instituut" Mededeeling No. 31, Afd. Handelsmuseum No. 12*, Amsterdam, 1933–1938 (translated by ROBERT L. PENDLETON 1944: "The Soils of Equatorial Regions, With Particular Reference to the Netherlands East Indies." Edwards Brothers, Ann Arbor, Mich.).

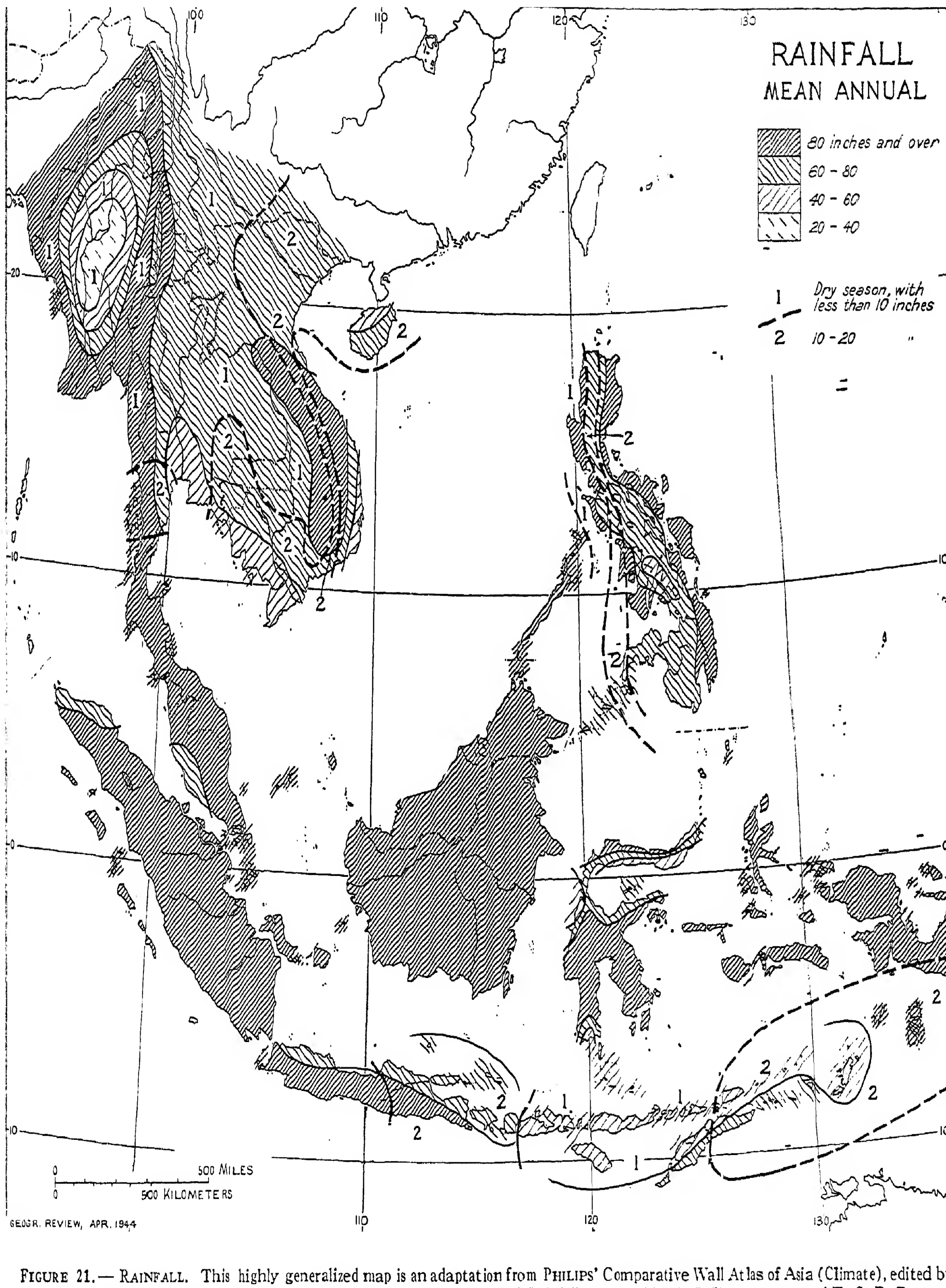


FIGURE 21.— RAINFALL. This highly generalized map is an adaptation from PHILIPS' Comparative Wall Atlas of Asia (Climate), edited by J. F. UNSTEAD and E. G. R. TAYLOR; Oxford Wall Maps: Asia, Mean Annual Rainfall, compiled by A. J. HERBERTSON and E. G. R. TAYLOR, 1909; C. BRAAK: Klimakunde von Hinterindien und Insulinde (Handbuch der Klimatologie, Vol. 4, Part R) Berlin, 1931. The rainfall for the dry season is based on the six months, October to March, in the Northern Hemisphere and April to September in the Southern Hemisphere. The areas marked 1, including Burma, most of Thailand and interior French Indochina, the northwestern Philippines, and the middle part of the Lesser Sunda Islands, have a pronounced "dry monsoon." Where these areas are well exposed to the rain-bearing winds (Burma coast, western Philippines), the rainfall during the wet monsoon is so large that the annual total is more than 80 inches and often is greater than the precipitation in equatorial areas (*e.g.* Akyab, on the Arakan coast, 207 inches).— Areas marked 2 have a less pronounced dry season and are transitional to the areas with "year-round" rainfall. Java, for example, is under the influence of the Asiatic (N.W.) monsoon from November to April; from May to October the southeast monsoon prevails, which brings rain to the south coast but in general is drier than the northwest monsoon. As a result, western Java and the entire south coast has a high annual rainfall (more than 80 inches) and no dry season, but the northeast has a rainfall between 60 and 80 inches and some months that are practically dry.

in southern Sumatra and, especially, in Mindanao reflects the immigration of Javanese and Filipinos respectively. In western Malaya and eastern Sumatra around Medan the rate is also strongly influenced by immigration, but here most of the immigrants have been "birds of passage" who arrived in large numbers during the boom years of rubber estates and tin mines and left in times of depression such as the early 1930's. Elsewhere the high rates of growth, if not the result of erroneous census estimates, seem to be largely caused by increase of the local population.

It should be repeated that the sparse settlement of, for instance, the plains of Borneo and New Guinea is no accident; their carrying capacity is inherently lower than that of the present areas of concentration. Proper regard for the rights of the local populations demands extensive reservation of arable lands for their future needs. This means that the area available for resettling the surplus population of the present crowded districts is much more restricted than would appear at first glance. It underscores the invalidity of Japanese claims for living space in these southern regions and serves as a warning against schemes for colonization by European refugees after the war.

The racial distribution also reflects the natural environment. The rugged and heavily forested uplands act as barriers between the lowlands. This is particularly true of the mainland, where north-south ranges have imposed a linear pattern on the migrations. In the archipelago the sea has acted as a link rather than as a barrier, so that here we find a more nearly concentric pattern of coastal and interior peoples. The consecutive eastward migrations of different racial groups have all left their mark on the region, from the oldest recognizable element, the Negrito, in remote jungle retreats, to the latest, and dominant, group of Mongoloid peoples. Of more significance for the postwar world, however, are the language groups, because these are an important factor in the pattern of nations, existing or emerging, in Southeast Asia (Fig. 24).

The isolated valleys of the Irrawaddy, the Menam, the Mekong, and the Red River and the narrow coastal plain of Annam have served as migration routes, as cultural cores, and as political key areas for, respectively, the Burmese, Thai, Cambodians, and Annamese. The numerous migrations and cultural impacts have created a highly complex situation. The early settlers have either been absorbed by the later groups or been pushed into the uplands. The Mon-Khmer peoples now appear as fragments all over Further India, their once solid hold on the region ripped apart by invasions of Burmese, Thai, and Annamese. The continental offshoot of the Malayo-Polynesian language group in French Indochina (the Cham and related peoples) now lives on as a much reduced group in the mountain refuge of the central Annamese range. The most recent immigrants seem to be the Miao-Yao tribes, who have been moving into the northern part of our area during the last centuries, probably under pressure of the Chinese proper.

In contrast with the extreme complexity of the mainland, the island world is rather simple in its basic language features, demonstrating again the unifying function of the sea. Over the entire area, from the Malay Peninsula northward to include part of Formosa and eastward to include the Moluccas (with the exception of northern Halmahera, of "Papuan" speech), the languages belong to one common stock, the so-called Malayan division of the Malayo-Polynesian group.

Within this division there exist, of course, a multitude of languages: in the Philippine Islands there are at least 60 different languages and dialects, and in the Netherlands Indies some 25 languages and about 250 dialects are reported.[3]

The social crazy quilt we see today in Southeast Asia is, however, only partly a result of the wanderings of what are now considered the indigenous peoples. One can go even further and say that the differences between them would be rather small had it not been for the impact of outside forces, first of more advanced Oriental civilizations, later of the Western world.

Before the Westerners found the way to tropical Asia, it had been for centuries a "colonial area" for both Hindus and Chinese. That meant — just as it does today — on the one hand exploitation by profiteering merchants and tribute-seeking conquerors, but on the other hand cultural enrichment, whether directly through active proselytizing or indirectly through imitation and adaptation. It was particularly the Hindu expansion in the early centuries of our era that introduced to the primitive, pagan, tribal societies of Southeast Asia the higher forms of religion, philosophy, literature, architecture, and political and social organization. The temples and palaces of present-day Burma, Thailand, and Bali and such classic monuments as Angkor in Cambodia and Borobudur in Java are symbols of the mighty impulses that came from India. These cultural advances were fairly strong in the lowlands but weak and retarded in the uplands The cultural influence of China was, on the whole, limited but predominates among the Annamese in the coastal area of French Indochina; here Confucianism, Buddhism, and ancestor worship mingle in true Chinese fashion and the Annam court and the mandarin bureaucracy bear clearly the stamp of Chinese tradition.

Later, about the fourteenth century, another outside force, Islam, made its impact on the region. Although its source was in the Near East, the new religion and its concomitant social-economic tenets were carried to the Indies by Mohammedan merchants from northwestern India. It spread steadily from the trade centers along the Strait of Malacca eastward and northward, and by the time the Portuguese arrived, Islam was dominant in the coastal regions of the Indies and had pushed north as far as Mindanao.

The political upheaval caused by the advent of Islam no doubt facilitated the penetration by Europeans, who could play the contending factions against one another. And, more important, the geographical limits of Islam at the time of the European invasion go far toward explaining the present peculiar position of the Filipinos in Southeast Asia. It is well known that Moslems are virtually immune to Christian missionary activity. Spanish colonial policy, which placed much stress on the spreading of the Christian faith, was very successful among the animist population of the Philippine Islands (except for the remote mountain tribes) but was never able to convert the Mohammedans of Mindanao, Palawan, and Sulu.

[3] Census of the Philippines, 1939, Vol. 2, p. 333; "Atlas van Tropisch Nederland," Koninklijk Nederlandsch Aardrijkskundig Genootschap in collaboration with the Topografische Dienst in Nederlandsch-Indië, 1938, Sheet 9b.

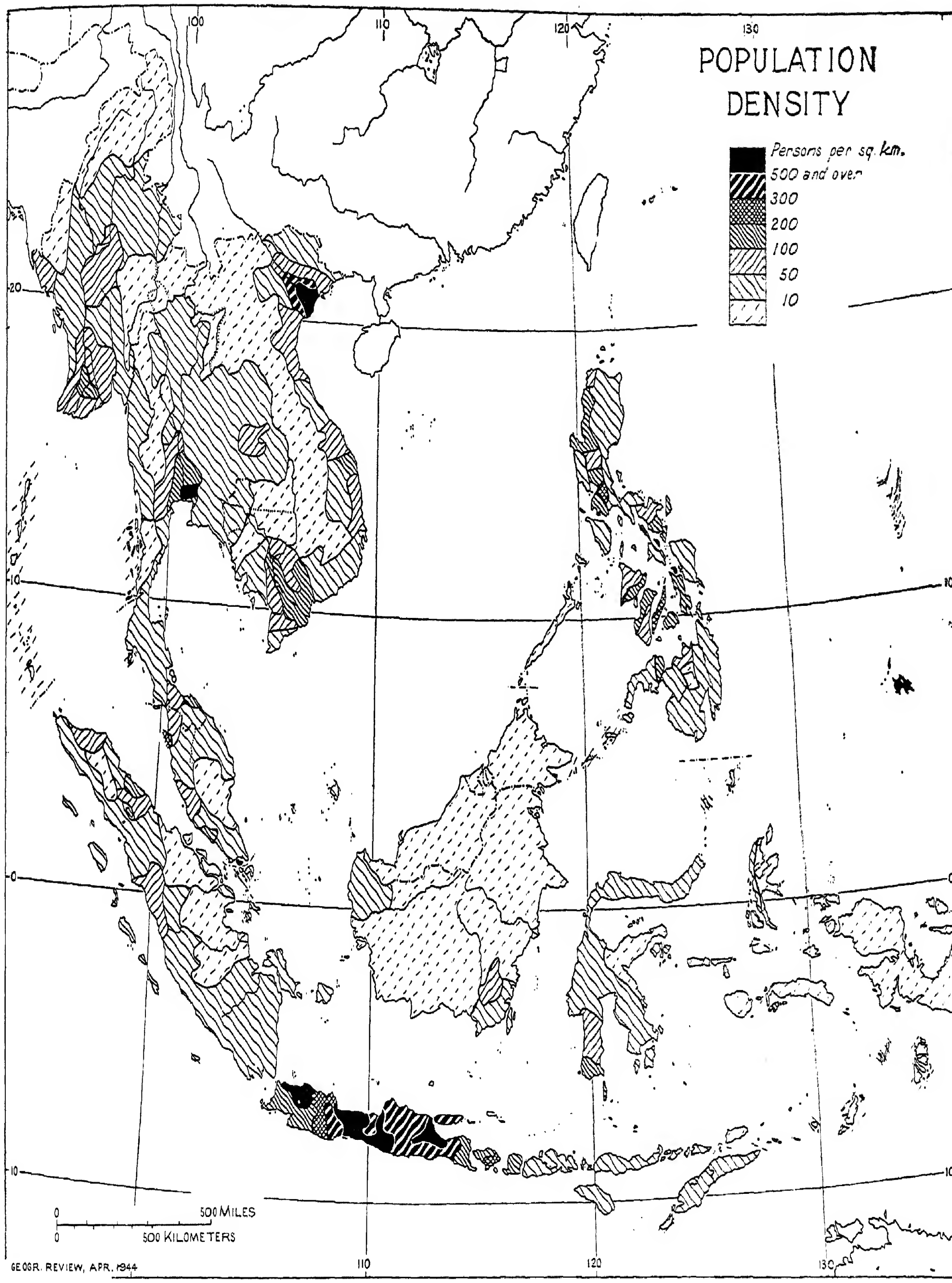


FIGURE 22.— POPULATION DENSITY. In order to present a comparable picture for the whole of Southeast Asia, the year 1940 or 1941 was chosen, and densities were calculated for administrative districts. This use of administrative districts for the sake of uniformity explains, for instance, the rather low density of the Annam coastal region, where the districts include large areas of sparsely settled uplands adjacent to the crowded coastal strip. The scale of the map required, of course, some generalizations where there were many small districts with differing densities (Tongking, Cochinchina, Java). Cities, where they formed separate census units, were included in the adjacent districts. — Sources:

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pp. 51–52 and 15–16 (the percentage of increase between 1931 and 1936 was used to compute the population figures for 1941); *Statistical Year Book— Siam*, 1933–1935 and 1936–1937, pp. 71–72 and 50–51 (estimate based on rate of increase between census years 1929 and 1937); Census of India, 1931, Vol. XI, Burma, Part 2, pp. 2–3 (estimate computed on basis of increase between census years 1921 and 1931. Certain remote areas were, however, excluded from the census. See explanatory note, Part 2, p. 1, and Part 1, Report, p. 223).

The so-called Moros are to this day a group apart from the Filipinos, and it appears that this Moslem minority has grave misgivings regarding its future position in an independent Philippine commonwealth. As to the remainder of the country, it must be said in justice to the Spaniards that it was they who, by their conversion policy, westernized the Filipinos and thereby created the spiritual conditions that led to the revolt against Spain and subsequently made possible the rapid progress in self-government under the American régime. This is too often forgotten by those who criticize what they consider the political or educational backwardness in the Indies or Malaya. It is interesting to note that in the Moro provinces of Cotabato (Mindanao) and Sulu the rate of literacy is the lowest in the Philippine Islands: although on the average 50 per cent of the Philippine population over 10 years of age can read and write, the percentage is 20 or less for these two provinces.[4]

There are other aspects of Western colonial policy that have tended to increase the contrasts between the parts of Southeast Asia. The trade of each of the countries shows that there has been very little exchange within the region. What intraregional commerce did exist was either for trans-shipment at Singapore or shipments of rice from the surplus lowlands of Cochinchina, Thailand, and Burma to such deficit areas of plantation economy as British Malaya and Sumatra. French Indochina and the Philippines, because of protectionist policies, had between one-half and three-fourths of their trade with France and the United States respectively. British Malaya and the Netherlands Indies were less dependent on their home countries, partly because of the world-wide demand for their products and partly because of a long tradition of free trade. Thailand, being outside any empire structure, also had more diversified trade, but this too was largely with the industrialized countries of the middle latitudes. Only Burma had its major market and supply area close by, namely in India, which took more than half its trade. Thus the commercial structure of the countries of Southeast Asia shows great similarity to that of the raw-materials-producing countries of Latin America: they face the world, turning their backs to one another.

Each colonial power has ruled, developed, or exploited its empire according to the ideologies and social and economic practices of the home country. The Americans have stressed political development, the French cultural assimilation, the British and Dutch economic progress, the former more in a laissez faire manner, the latter in a more paternal form. No doubt the foreign domination has created greater unity *within* each dependency. If the manifold peoples of the Netherlands Indies now begin to feel the bonds of an Indonesian nation, if the native leaders on the Peninsula look forward toward a unified national Malay state, it is due to the unification under Western rule and the penetration of Western ideas of nationalism. At the same time, however, this rising national consciousness within each dependency sharpens the division between the political units of Southeast Asia. For instance, the Malayan peoples of the Peninsula, the Indies, and the Philippines have many basic cultural traits in common, but the different forms of colonial rule have created divergent interests that cannot be ignored. It seems out of the question that the Filipinos, eagerly awaiting their independence, would agree to be part of a Malayan superstate, especially if this were placed under international supervision. And even if they were willing, the Indonesians would most likely reject the scheme because they would fear the power of the politically more advanced Filipinos and the possible friction between Moslem and Christian interests. A union of British Malaya and the Netherlands Indies would not present these particular problems, but — quite apart, of course, from Dutch or British objections — it is doubtful whether the Indonesians would welcome the addition of a substantial and concentrated Chinese minority such as exists in British Malaya.

On the mainland one finds similar hurdles in the path toward a fusion. National consciousness among the Burmese, Thai, and Annamese is relatively strong, rooted in old traditions and fortified by resistance to Western dominance. Japan rewarded Thailand by giving it parts of French Indochina (in Laos and Cambodia), of British Malaya (the four northern states), and of Burma (part of the Southern Shan States). The annexations in Laos and part of the Shan territory may have some ground in that the inhabitants show more affinity to the Thai than to the peoples of Thailand's neighbor states. The other additions, however, are based on tenuous claims of former suzerainty. There is little doubt that this generosity of Japan is resented by Thailand's neighbors. Whatever boundaries result from the future peace conference, they will cause ill feeling and form a hindrance to close collaboration within a federation.

**Regional Problems:** — In view of these contrasts and divergent interests one may well ask whether there is any sense in dealing with Southeast Asia as a regional unit. The answer is that, in spite of all the differences noted, there are certain considerations of a broader nature and of far-reaching significance that give validity to the concept.

There is, in the first place, the "colonial" character of the region. In recent years there has been increasing acceptance of the thesis that "the colonial powers are not only in a position of trustees towards the colonial areas under their rule, but that they also owe a moral obligation toward the rest of the world to account for their stewardship."[5] Although an international administration over the whole region is neither a practical nor a desirable solution, there is much to be said for a regional supervisory organ embodying this "third-party interest," at least if this principle finds application to all colonial areas of the world. In this line of thought the colonial powers, after the expulsion of Japan, would resume charge of their respective dependencies but would be accountable to an international authority.

The function of this international body should not, however, be limited merely to supervising the progress made toward self-government. Political rights are meaningless unless they rest on a

[4] Census of the Philippines, 1939, Vol. 2, pp. 298 ff. and 385 ff. Literacy for females is particularly low: 13.1 per cent in Cotabato and 16.1 per cent in Sulu. It may be added that literacy in the pagan Mountain Province is 29.1 per cent.

[5] "War and Peace in the Pacific: A Preliminary Report of the Eighth Conference of the Institute of Pacific Relations . . . , Mont Tremblant, December 4–14, 1942," International Secretariat, Institute of Pacific Relations, New York, 1943, p. 56.

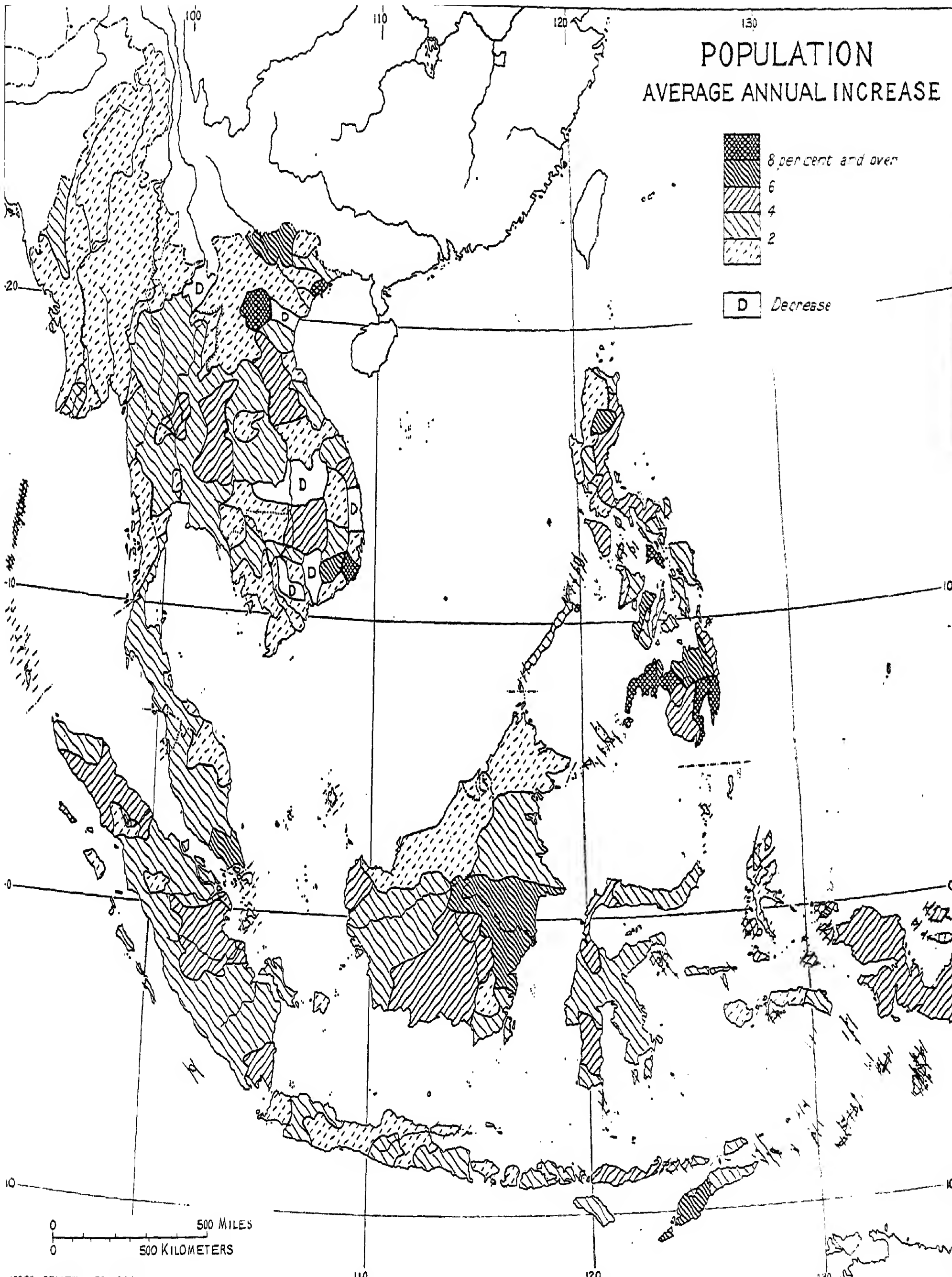


FIGURE 23. — POPULATION CHANGE. This is, so far as known, the first attempt to give a comprehensive view of the crude rate of population growth in Southeast Asia, but the map cannot rise above the level of available information. The cartographic presentation points up clearly the doubtful quality of census data over large parts of this region (see, for instance, French Indochina or the contrast between Burma and Thailand). However, the enumeration methods employed in the Philippines, Java, Bali, most of Sumatra, northern and southern Celebes, British Malaya, and Burma proper indicate reasonable accuracy. In Burma and the Netherlands Indies the rates of growth refer to the periods 1921–1931 and 1920–1930, respectively. The increase shown in southern Sumatra (Lampongs) is doubtless below the rate that prevailed in the 1930's, when Javanese immigration was accelerated. Altogether, the rates are high, as the corresponding percentages for some other countries show: Japan proper, 1.12; India, 1.5; Italy, 0.98; U.S.A., 0.72; Great Britain, 0.4. — The map is based on the crude gain (or loss) between the two most recent official censuses. For sources see Fig. 22.

sound social and economic foundation. If the outside powers, in the spirit of the Atlantic Charter, wish to have a part in the political development of the dependencies, they will also have to accept a share in the responsibility for the material welfare of these lands. It would be strange indeed if public opinion, say in the United States, could demand that full democracy be established in Malaya and at the same time disclaim any concern for the economic conditions in that country. This raises the question of the economic future of Southeast Asia to cardinal importance.

**Rôle of Raw-Materials Export:** — In the past the export of commodities gained from field, forest, and mine has provided the revenues with which to pay for improvements. A peasant society is naturally poor in capital. The investments made by Westerners and, to a small extent, by Chinese and Indians (the latter mainly in Burma) have, no doubt, been profitable to them. But the native peoples have also gained on the whole, not only by better opportunities for employment, but especially by obtaining roads, ports, waterworks, hospitals, experiment stations, and other durable improvements. There are, of course, differences of opinion as to whether the native peoples have received their fair share of the profits and, if not, how this should be corrected after the war. Nevertheless, improvement of living conditions will still depend largely on the import of capital, equipment, and services. Will Southeast Asia be able to pay for these necessities in the traditional manner?

We are now painfully aware that Southeast Asia had been developed into a veritable treasure house of raw materials. It produced almost all the natural rubber, cinchona bark, abacá (Manila hemp), kapok, teakwood, and pepper of the world, three-fourths of the copra and tapioca flour, more than half the palm oil and tin, and one-third of the agave fibers (sisal and henequen). The region was also of great importance for natural resins and gums and for essential oils; for instance, most of the jelutong (an ingredient of chewing gum) and three-fourths of the citronella oil came from here. Another product, seemingly minor but actually highly important, was the versatile insecticide rotenone. Its production has expanded rapidly in the last ten years, and British Malaya and the Netherlands Indies had almost a monopoly on the world market.

In addition, Southeast Asia produced considerable quantities of cane sugar (14 per cent of the world production), tea (18 per cent), tobacco, spices, and rare metals such as tungsten (22 per cent).[6]

Southeast Asia has experienced an extraordinary economic development since about the middle of the nineteenth century. While the economy of Latin America stagnated because of the abolition of slavery and the instability of governments, colonial Southeast Asia, brought closer to Europe by the Suez Canal, became the great tropical supply center for Western industry. This paramount position is now seriously threatened from two directions: preparation for war and the war itself have led to the development of synthetic substitutes in the industrial countries and the introduction or expansion of natural production in the tropical parts of India, Africa, and, especially, South America. Not all these ventures will succeed, but even if only a part survive the war, it will mean a considerable competition for Southeast Asia. This competition will not be merely on the basis of price and quality — on which tropical Asia might, on the whole, have the stronger position — but will also involve political and national considerations. The lesson of the danger of relying on distant countries for strategic raw materials may result, in Europe as well as in America, in the maintenance of home production of synthetics at whatever cost; concern for the large capital invested in the new industries (for synthetic rubber in the United States some 625 million dollars) would certainly support such a policy. Or, for instance, the "good-neighbor policy" toward Latin America might induce the United States to give preference to the new or revived products of that region. Expansion of trade outlets in other countries may partly make up for the loss elsewhere. For instance, if China is helped to its feet and its transportation system and industry are developed, resulting in greater consuming power, it may become a substantial customer for rubber, fibers, industrial fats and oils, and foodstuffs. Even so, it is hard to see how Southeast Asia can regain its former export volume. The repercussions on the social-economic structure will be severe, unless, as suggested above, the more advanced nations recognize their responsibility for doing more than expressing sympathy with political ideals.

**New Opportunities:** — The future will demand a new approach. It is too early to draw up any specific long-range plans, and the problems differ, of course, for the different countries of Southeast Asia, but some brief suggestions may illustrate the possibilities.

The decline of exporting may, to some extent, prove a blessing in disguise if countered by a constructive readjustment policy. A shift in emphasis from a few export commodities to a more diversified agriculture would increase economic resistance in depression years. The disastrous period of the early 1930's taught a hard lesson, and some beneficial changes occurred, but they were minor compared with those that the post-war period will require. British Malaya, especially, needs more home production of food; normally it imported about two-thirds of its rice consumption.

Another item for a long-range reconstruction program is resettlement, either to relieve the population pressure in overcrowded areas or to furnish a new livelihood for workers in depressed export industries. In the preceding decade energetic efforts were made to promote emigration from Java to Sumatra and from Luzon to Mindanao. The initial results were promising, but too small to afford any material relief as yet.[7]

[6] The percentages refer to 1938 or 1939 and are taken from the *Statistical Year-Book of the League of Nations* and the *Agricultural Export Crops of the Netherlands Indies* (annual) for 1940.

[7] The number of colonists leaving Java rose from 20,000 in 1937 to 53,000 in 1940. For a description of the new resettlement program see "Agricultural Colonization and the Population of Java." *The Netherlands Indies*, Dept. van Economische Zaken, Netherlands Indies, Vol. 6, No. 8, 1938, pp. 11 ff.; "Javanese Colonization in the Outer Provinces," *ibid.*, No. 9, 1938, p. [illegible]; [illegible]: Towards Economic Democracy in the Netherlands Indies. [*Netherlands-Netherlands Indies Paper No. 5*], Netherlands-Netherlands Indies Council, Institute of Pacific Relations, 1942; WIBO PEEKEMA: Colonization of Javanese in the Outer Provinces of the Netherlands East-Indies. *Geogr. Journ.*, Vol. 101, 1943, pp. 145–153. In the Philippine commonwealth, under the auspices of the National Land Settlement Administration, it has been reported that 11,500 persons were settled in Mindanao in 1939 and 1940.

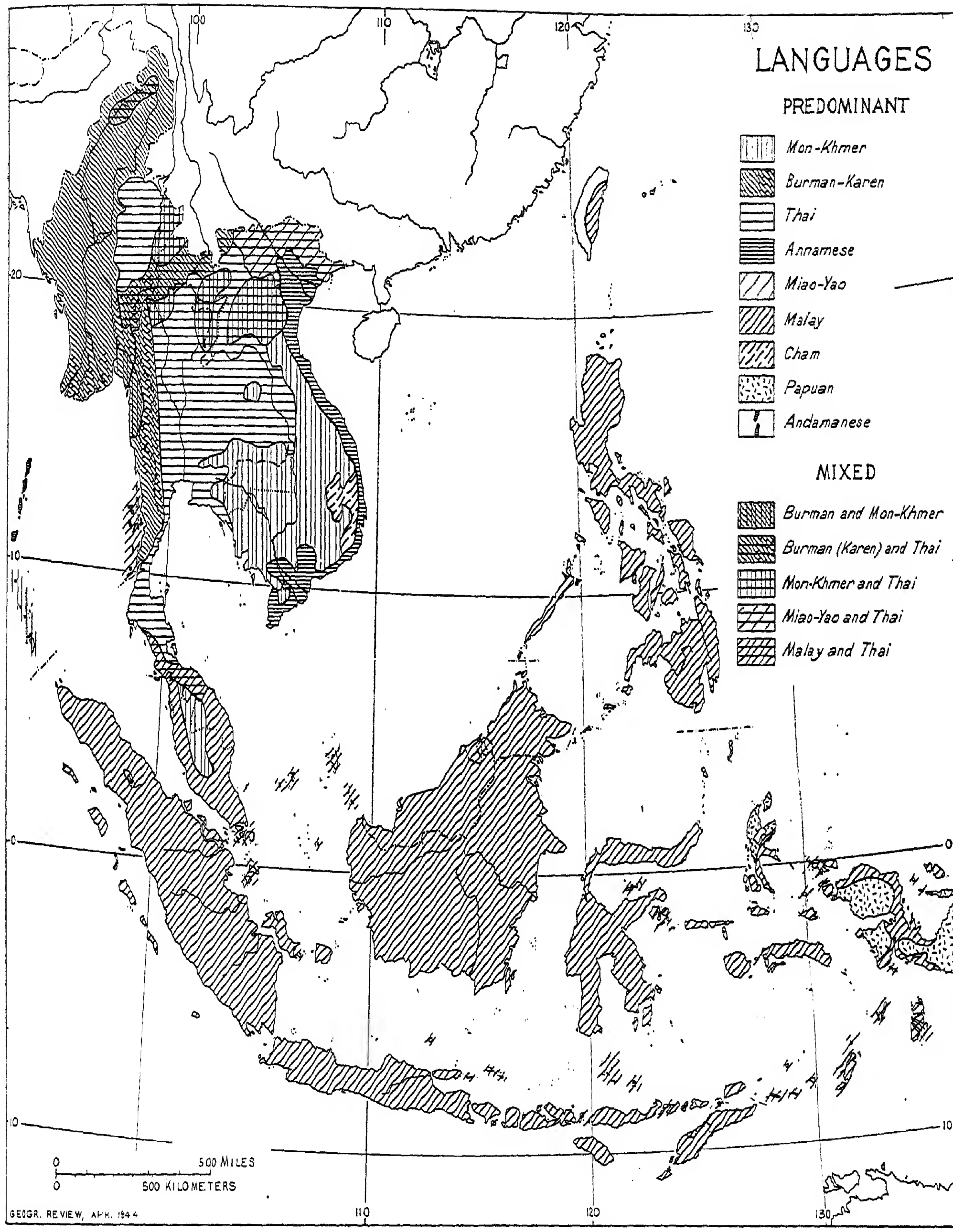


FIGURE 24. —LANGUAGES. This is a simplified version of a more detailed manuscript map compiled by Dr. PAUL K. BENEDICT and the author. Small "islands" of foreign language stocks, such as cities and plantation and mining areas, had to be omitted (for instance, one-half of Rangoon's population was Indian, more than three-fourths of Singapore's Chinese). The Andamanese languages had to be given a separate symbol because they have no known affinity to any other language. The 400 native Negritos are now only a remnant, a small minority compared with the 20,000 Indians and Burmese in the penal and free colonies around Port Blair on South Andaman Island. Cham is generally recognized as a branch of the Malayan language family; its location indicates sea-borne migration, perhaps from South China (P. K. BENEDICT: Thai, Kadai, and Indonesian: A New Alignment in Southeastern Asia. *Amer. Anthropologist*, Vol. 44 [N.S.], 1942, pp. 576–601). — Sources include: Atlas van Tropisch Nederland, 1938, sheet 9b; A. L. KROEBER: Peoples of the Philippines. *Amer. Museum of Nat. Hist. Handbook Ser. No. 8*, 1919; L. DE LA JONQUIÈRE: Ethnographie du Tonkin septentrional. Paris, 1906; HENRI MASPÉRO's chapter on languages in "Un empire colonial français: L'Indochine," edited by GEORGES MASPÉRO, Vol. I, Paris and Brussels, 1929, pp. 63–80; WILHELM CREDNER: Siam, das Land der Tai. Stuttgart, 1935; P. SCHEBESTA and K. STREIT: Völker- und Stammkarte der Orang-Utan von Malaya. *Petermanns Mitt.*, Vol. 72, 1926, Pl. 21; E. H. MAN: On the Aboriginal Inhabitants of the Andaman Islands. London, 1932; *idem:* The Nicobar Islands and Their People. Guildford [1932?]; Census of India, 1931, Vol. II, The Andaman and Nicobar Islands, and Vol. XI, Burma, Part 1, Linguistic Map.

This work will have to be resumed on a much larger scale.

The development of manufacturing industries is another approach to betterment, and more stimulating than the spread of subsistence agriculture under the resettlement schemes. Moreover, it will be a necessity if the shrunken export markets do not provide enough money to buy manufactured goods abroad. The favorable results obtained in Java in the 1930's under a social policy of encouraging small-scale factories for the production of daily necessities are guideposts for the future.[8] In addition to Java, central Luzon, lower Tongking, and possibly the districts around Rangoon, Bangkok, and Singapore may well become centers of consumers' goods industries, selling on the Oriental price level. This activity, in turn, induces the establishment of more basic industries, as the experience of Java has shown. Such industrial centers will also supply the outlying agrarian regions, and closer trade relations will result. This was already noticeable in the Netherlands Indies; under the stimulus of expanding factory production, the value of Java's exports of manufactured goods to the other islands rose from 34 million guilders in 1934 to 70 million in 1940.

The question whether Southeast Asia will develop a heavy industry is still academic. The possibilities cannot be discounted merely because the region has little or no metallurgical coal and relatively small iron deposits. These twin elements of the early Industrial Revolution are becoming less important as technology advances. Because of its heavy rainfall and strong relief, Southeast Asia has considerable potential water power. In addition, metal alloys and plastics are bound to play a much greater rôle than in the past. The region has many metals, such as tin, aluminum, chromium, manganese, and tungsten, and enormous forest reserves, which some day will yield the raw material for various kinds of wood plastics.

Industrialization and the concomitant changes in social-economic organization will tend to lower the birth rate, as has happened in other countries. It is only by this process that we can hope to break the vicious circle in which a rise in living standards is nullified by increased survival.

The development of manufacturing will, again, depend largely on the assistance of the Western nations in supplying capital, equipment, and technical assistance. This may seem an invitation to the present industrial nations to cut their own throats, but experience has shown that the flow of trade among industrial countries is greater than that between industrial and raw-materials-producing countries.

**Toward a Regional Bloc:** — Although Southeast Asia will thus be still dependent on Western countries, the peoples of the region can strengthen and speed up their progress toward economic self-determination by regional collaboration.[9] A political, territorial fusion directly after the war would, as discussed above, cause more harm than good; but a regional bloc, working along functional lines, appears as a distinct possibility. Even if an international colonial authority should not materialize, a purely regional organization for consultation and coordination could be set up. The recently created Anglo-American Caribbean Commission is an example of such regional collaboration. A number of committees, acting under a secretariat as the regional clearing-house, should examine the problems of the region as a whole, as well as the intraregional sources of friction.

For instance, although the problem of raw materials can, obviously, be solved only by worldwide agreements, a united stand by the countries of tropical Asia would considerably strengthen their position at the conference table. Other regional topics needing discussion and, where feasible, a common policy, are regulation of immigration, labor conditions, intra-regional shipping, and aviation. Furthermore, there should be a regular interchange of information on such matters as education, public hygiene, nutrition, resettlement, rural credit, agricultural methods, and industrial development in order to promote the rapid spread of effective welfare policies.

**Local Unity:** — This idea of community of interests — whether from an internal or an external viewpoint — also appears in the character of Southeast Asia as a transit area. This has long been recognized for the Malay Archipelago and the adjacent Peninsula: these lands astride the equator act as a barrier guarding the gateway between the Pacific and Indian Oceans and at the same time form steppingstones between Asia and Australia. Together with the other two bottlenecks of world shipping — the Caribbean with the Panama Canal and the Mediterranean with the Suez Canal — Malaysia forms the trinity of strategic thoroughfares on which world sea power rests. French Indochina and the Philippines, flanking the South China Sea, guard the portals to the Malacca and Sunda Straits; Thailand borders on the Pacific as well as on the Indian Ocean and controls the Isthmus of Kra, the potential site for a canal linking the two oceans. This strategic position of Southeast Asia has been emphasized in recent years by the emergence of Burma as a transit zone between China and the Indian Ocean. Air transportation will certainly play a large rôle after the war, but it will not replace land and sea transportation. It would seem that the future system of skyways will even accentuate the position of Southeast Asia as a crossroads center. Here the great-circle route from the Pacific coast of America via Japan to East China, the Philippines, and Singapore meets the transpacific "island hopping" line via Hawaii and also the route from Australia to India and beyond to West Asia and Europe.

These functions give Southeast Asia a vital place in the world's circulatory system and make its security a matter of international concern. In this respect no part of the region can be separated from the whole; when Japan penetrated into French Indochina, the entire structure of Western domination in Southeast Asia was doomed. In the same way, when Japan was expelled from the Philippine Islands, its entire newly won empire started to crumble.

This strategic interdependence has even more direct bearing on the fate of the peoples of Southeast Asia as they approach the stage of self-rule. The historical development points clearly to the eventual emergence of at least six national states

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[8] P. H. W. SITSEN: Industrial Development of the Netherlands Indies. *Bull. 2*, Netherlands-Netherlands Indies Council, Institute of Pacific Relations.

[9] BRUNO LASKER: Welfare and Freedom in Postwar Southeast Asia. *Amer. Council Paper No. 3*, American Council, Institute of Pacific Relations, New York, n.d. [illegible]: "International Action and the Colonies." [illegible] *Research Ser. No. 65*, 1943.

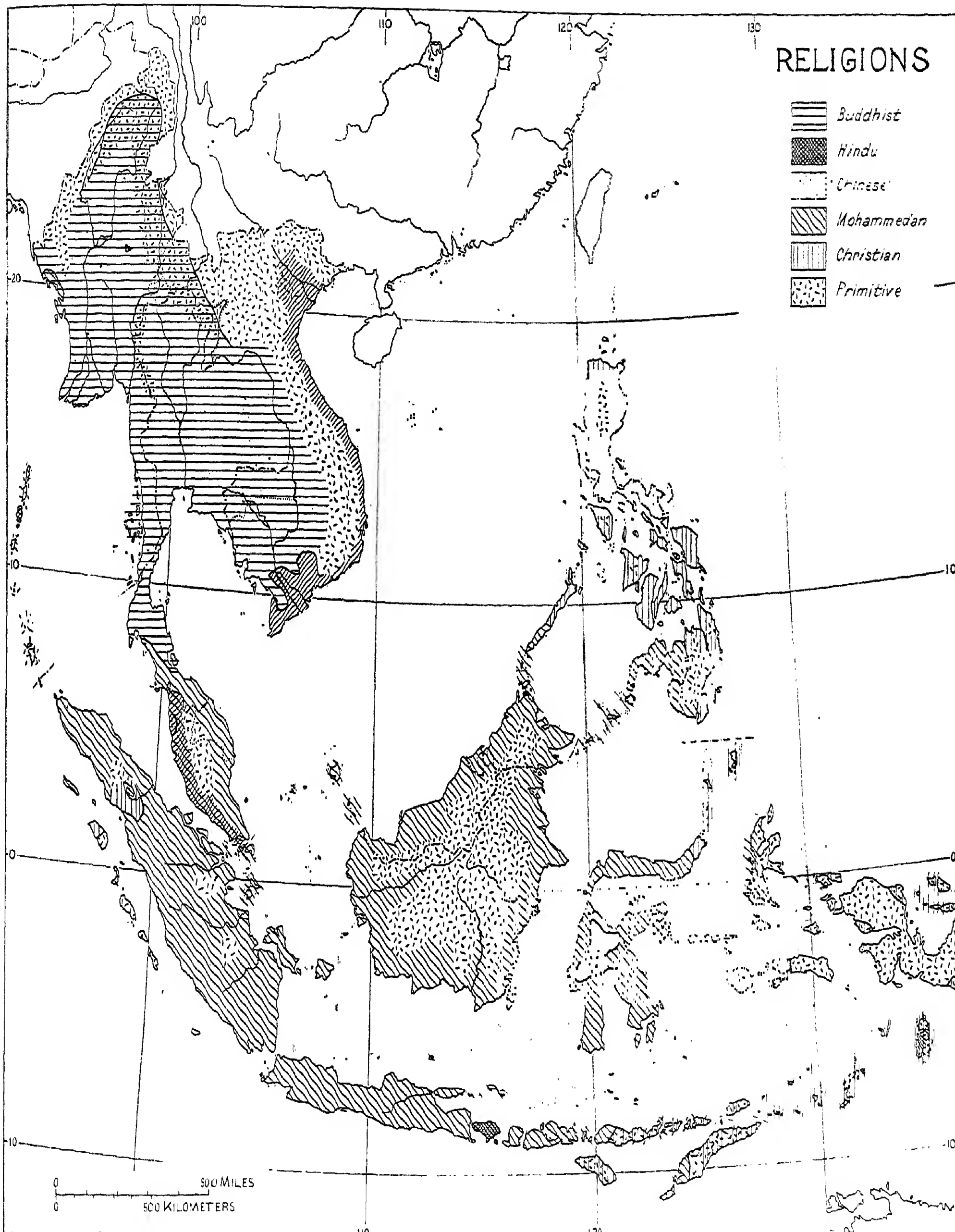


FIGURE 25.— RELIGIONS. For large parts of the region data on religion are either lacking or vague; one reason is, of course, that the subject defies exact definition. What is described in the legend as "Chinese" religion is a mixture of Buddhism, Confucianism, and ancestor worship, and it is hard to say where the boundary lies between this and animistic beliefs. The Annamese language boundary has largely been followed. Such transition zones also exist on the frontiers of other religions. The purpose was, as in Figure 24, to show the broad divisions. There are, for instance, Christian missions all over Southeast Asia, but where they form relatively small minorities, as among the Karen in Burma, the hill tribes of Indochina, or on Java, they have been omitted. On the other hand, Christianity has a strong foothold or even predominance among the Bataks of north-central Sumatra and the primitive tribes of the eastern islands. In this latter area Islam is also still making progress, but mostly in and around local ports. Note the relic area of Hinduism on Bali. The Netherlands Indies census has no complete data on religion but gives detailed information on certain areas with large Christian populations (Volkstelling, 1930, Part 4, pp. 83 ff. and Part 5, pp. 91 ff.). Supplementary statistical information can be found in *Indisch Verslag*, Vol. 2, in the chapter "Eeredienst en." The boundary of primitive religon in Borneo follows rather closely the boundary of the Dyak languages. — For other countries the data either have been taken from official sources already mentioned or are based on missionary publications, regional descriptions, and information from former residents.

in this region. They will be flanked by Australia, India, and China, and to the north will be Japan, which in spite of defeat may remain a potentially formidable nation. If for the moment we leave open the question of Japan's future power and omit Australia as actually only a small nation in terms of population and remote from most of the Southeast Asiatic countries, the contrast between Southeast Asia and its immediate neighbors becomes even stronger.

The thought occurs that the fragmentation of Southeast Asia into six separate states or more may create an "Asiatic Balkans," destined to become a pawn in an eventual struggle for political or economic supremacy between its great neighbors. Speculation on such contingencies can hardly form a compelling argument for the establishment of a regional bloc. We have seen, however, that there are other — and urgent — problems that require regional solution. Cooperation on concrete questions of colonial emancipation, security, and welfare may gradually establish a sense of unity that will transcend local divergences. It is through this organic evolution toward interdependence that Southeast Asia will become strong enough to ward off outside pressure and gain genuine freedom.

The concept of the national sovereign state is essentially a product of European culture. No one will deny the stimulative qualities of a vigorous national life, but neither can anyone fail to see what chaos has been caused by nationalistic anarchy. While the Western world is searching for an escape from this impasse, tropical Asia is struggling toward national self-determination.

Must these peoples travel the same road as Europe did, or will they be able to subordinate patriotism to collective regional interests? It seems not yet too late — if the Western nations recognize their true responsibility — to guide Southeast Asia toward a future in which "interdependence" will be as challenging a word as "independence" is today.

# The Organization devised by the International Rubber Regulation Committee for the Conduct of Research and Propaganda, under the 1934 Agreement between the Governments of France, the United Kingdom, India, the Netherlands, and Siam, to regulate the Production and Export of Rubber.

*by*

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**Introduction:** — The plantation rubber industry is identified with the successful translation to the Far Eastern tropics of *Hevea brasiliensis*, a large forest tree indigenous to the Amazon Valley. It had its genesis in the experiments set in motion by CLEMENTS MARKHAM, a British India Official in the 1870's, and by 1940 some 9,000,000 acres had been laid down to the cultivation, chiefly in the Malayan peninsula, the Netherlands East Indies, French Indo-China, Ceylon and S. India, capable of producing annually 1½ million tons of raw rubber.

Research played a conspicuous part in the development of the industry. From 1909/10 when research stations were established in Malaya and Ceylon under the auspices of the Rubber Growers' Association Inc., London, producers had progressively strengthened research directed to optimum economic production and 1940 found Malaya, the Netherlands East Indies and Ceylon well equipped with up-to-date research and experiment stations working to that end. Concurrently manufacturers and others, including the Rubber Growers' Association, London, the London Advisory Committee for Rubber Research (Ceylon & Malaya), London, the Research Association of British Rubber Manufacturers, Croydon, the Government Rubber Laboratories, Delft, the Rubber Department of the West Java Experiment Station, and the International Association, Holland, had been conducting research on post production problems and it had become customary to distinguish activities in the two fields as production- and consumption-research.

The field of consumption-research had from time to time come under review by producers, who had to rectify the position when production and consumption got out of balance, as to its adequacy in finding new outlets for their product. It was readily conceded that in this field the research organizations of the large manufacturers, particularly in North America, and of the makers of chemicals and accessory materials used in rubber processing were of pre-eminent importance in size, scope, and efficiency: that their research activities included research into fundamental problems, the results of which received considerable publicity when that could be given without detriment to business interests and that with the supplementary information emerging in due course in the records of patent literature, they had contributed the bulk of the substantial public record of the science of rubber itself and of the technology of manufacture. But it was felt that in some respects the interests of producers and manufacturers might be temporarily divergent in that much of the manufacturers' research was directed to the durability of rubber goods,

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

thereby braking rubber consumption: that there were fields of research which were not their primary concern, notably the exploration of rubber as a base from which to make new materials: that in the translation of laboratory results to industry producers might be expected to underwrite the hazards attendent on development, and that above all they should create an organization which could conduct fundamental research without regard to whether or when the knowledge so obtained would lead to commercial results and which for that reason had not been a priority in manufacturers' research programmes. Superimposed on these considerations were the results of research activities directed to synthetic alternatives which had thrown into bold relief certain relative imperfections of natural rubber when called to meet exacting specifications for solvent resistance etc. and the need to augment research in this direction was clearly indicated.

Propaganda had similarly played a part in the development of the industry. Manufacturers generally had conducted wide-scale publicity for proprietary rubber goods, and producers, notably the Rubber Growers' Association, London, while conducting a general campaign to make the populace rubber-minded had amongst other things participated in national and international exhibitions, had stationed officers at various times in Australia, Belgium and France, and America had issued in the aggregate some 1½ million handbooks and pamphlets, including 14 in foreign languages, had initiated work on rubber roads, constituted a technical consultant service and co-operated with manufacturers in publicity for rubber flooring etc.

With a prospect of the Agreement to regulate output being renewed (as it was in 1938) opportunity was taken to explore the possibility of creating an international organization to be financed by all subscribers to the Regulation Agreement which would ensure an extension of fundamental research and a consequent broadening of the foundation of the research structure; which would integrate the current activities of producers in the fields of applied research and propaganda and by effective co-ordination over the whole field not only preclude unnecessary duplication but ensure maximum economy and efficiency.

**The 1934 Agreement:** — Under Article 19 of the Inter-Governmental Agreement to regulate the Production and Export of Rubber, signed in London on 7th May, 1934, "The contracting Governments, recognizing that a natural balancing of production and consumption can be hastened by research with a view to developing new applications and by propaganda, declared that they would consider the possibility of
(*i*) levying and collecting a uniform cess on the net exports from their respective territories during the period of the Regulation for the purpose of supporting such research and propaganda, and
(*ii*) co-operating in the constitution of an International Rubber Research Board to plan the research and propaganda."

The responsibility for examining the possibilities and advising the signatory Governments as to appropriate action to be taken devolved on the International Rubber Regulation Committee.

The problems resolved themselves in the main into examining the possibilities of creating an organization of requisite scope which would utilize special talent in the Netherlands, France and Great Britain, adequate to supplement the progressive research work of the manufacturers especially in the direction of fundamental research and not only enlist their goodwill but stimulate their co-operation; which would explore fully the scientific basis underlying the competitive position of natural rubber in relation to synthetics, and which would indirectly give further concrete expression of the spirit of international co-operation for the common good expressed in the 1934 Agreement.

**The Examination of the Possibilities adumbrated in the 1934 Agreement:** — The following in brief outline covers the more important steps in the examination of the possibilities set out in Article 19 of the Agreement.

In May 1934 the International Rubber Regulation Committee invited the Rubber Growers' Association and its opposite number in Holland — the International Association — both of which were conducting consumption research and propaganda, to consider Article 19 and make recommendations thereon. These two Associations in joint report acknowledged the necessity for augmenting the respective services, approved the principle of cess collection, suggested that a cess of 1*d* per 100 lb. annually on exports would provide sufficient funds and that separate Associations should be entrusted with the responsibilities of the scheme by expanding their respective organizations within the limits of the cess income which would accrue nationally and by conducting their work on a co-ordinated pattern. This joint report indicated that the French growers would support the proposals and ask the Rubber Growers' Association to administer cess funds of French incidence.

In December 1934 the International Rubber Regulation Committee consulted Sir FRANK SMITH, then Secretary of the Department of Scientific and Industrial Research (England), who advised that any scheme of such importance should see continuity for a minimum period of 10 years, that an annual income of £100,000.- per annum, would not be out of proportion, and that due regard should be paid to the necessity of setting on foot long range (fundamental) investigations.

In January 1935, with the above-mentioned reports before them the International Rubber Regulation Committee set up a Sub-Committee under the Chairmanship of Sir ANDREW McFADYEAN, the other members being: — Messrs. D. BOLDERHEY, L. P. LE COSQUINO DE BUSSY, J. G. HAY, H. ERIC MILLER: "to consider the joint report of the Rubber Growers' Association and the International Association, Holland, the note by Sir FRANK SMITH, the opinions expressed by members . . . to prepare a scheme for research and propaganda as contemplated in Article 19 of the Agreement which in their view the Committee would be justified in recommending to the different Governments."

Over the period February March 1935 this Sub-Committee held several meetings, examined various witnesses and drew up its report.

**The Recommendations of the McFadyean Sub-Committee:** — For research, the McFadyean Sub-Committee recommended a major departure from that adumbrated in Article 19 of the Agree-

ment. Whereas the latter suggested the possible creation of a centralized planning and executive International Rubber Research Board (which, to have ensured unfettered working, would have entailed the pooling, at least in part, of funds of national incidence and the appointment of a principal technical officer charged to direct work over the whole international field) the Sub-Committee recommended the creation of three national autonomous research boards charged to satisfy a Board, international in character and elected therefrom, as to the co-ordinative pattern of their programmes as a whole. In short for research the Sub-Committee recommended a policy of decentralization.

In brief the Sub-Committee's recommendations were: —

*A.* That the signatory Governments should guarantee to continue the collection of an export cess for a period of 10 years irrespective of the fate of the International Rubber Regulation Agreement and that in the first instance a cess of 1d per 100lbs. should be collected, the rates to be reviewed from time to time in consonance with the requirements of the scheme as shown in its actual working.

*B.* That 3 National Research Boards should be set up, each responsible for the administration of cess income accruing nationally and charged

(*i*) to co-operate with each other in the conduct of research;

(*ii*) to submit their programmes (as to the measure of their co-ordination) and relative budgets of expenditure to,

*C.* An International Rubber Research Board representative of and elected from the 3 National Research Boards (ultimately constituted as to 3 members each of the British and Netherlands Boards and 2 of the French Board) charged

(*i*) to co-ordinate as far as possible by continuous contacts with each national board the research programmes undertaken by them,

(*ii*) to appoint a Chairman for an International Rubber Propaganda Committee,

(*iii*) to decide on the proportion of Cess Income to be allocated for propaganda activities,

(*iv*) to advise the Governments periodically on the adequacy or otherwise of Cess Income and to be the clearing house for all reports thereto.

*D.* That as regards the British Research Unit a centralized Institute should be set up under the control of a Board which should combine responsibility for representing producing territories and for working the Institute. To these ends the Sub-Committee recommended the appointment to the Board of 4 appointees of the Colonial Office with the consent of, and on behalf of, the Governments of the producing countries within the Empire which would contribute the funds, and 2 members nominated by the Rubber Growers' Association. The Sub-Committee recommended that of the former two should be conversant with the chemical and physical aspects of rubber science, another with the administration of schemes of scientific research and another of admitted business and administration capacity and experience.

*E.* That for Propaganda, planning and management should be centralized in an International Committee as follows:—

Chairman appointed by the International Rubber Research Board,

2 Nominees each of the Rubber Growers' Association and Netherlands Rubber Research Board, and

1 nominee of the French Rubber Research Board.

This Committee to be financed at the discretion of the International Rubber Research Board up to one-fifth of the total Cess Income, and to be served by a full time propaganda officer directive over the whole International field.

*F.* That the then current consumption-research and propaganda activities being carried out by producers be absorbed and where possible be integrated into the consolidated programme of the new organizations with the merging of the finance.

*G.* That in the event of the French interests not electing to create their own Unit but placing their funds under British administration corresponding representation should be made for them on the appropriate governing board.

*H.* That the co-operation of manufacturers should be provided for by the appointment of an Advisory Committee.

It was found in giving practical effect to these recommendations that de-centralization was necessary for Propaganda, similar to that recommended for Research.

On the 26th March 1935 the report of the McFADYEAN Sub-Committee was accepted by the International Rubber Regulation Committee and forwarded to the signatory governments with the recommendation to institute the proposed organization 1st October, 1936.

On 30th June, 1936, it was decided to send the report t• the Rubber Growers' Association inviting acceptance: this was readily forthcoming during the next few months.

By 26th January 1937, the Governments of British North Borneo, Ceylon, Malaya and Netherlands East Indies had undertaken to collect the cess "so long as the export of rubber was regulated," the Government of India and Burma having agreed for the present period only.

Meanwhile negotiations for a prolongation of the Inter-Governmental Agreement 1934 expiring on 31st December 1938, had been under way and a revised agreement extending the period to 31st December 1943 was implemented.

**The Organization as Finally Set Up:** — The scheme on p. 51 shows the organization as finally set up. The composition and sectional representation in the various units are given in Appendix (*i*). It should be explained that the International Rubber Research Board was not the centre of directive control but acted as a co-ordinating clearing house to the International Rubber Regulation Committee.

**The Impact of the War:** — The invasion of the Low Countries in June 1940 dismembered the organization and robbed it of its representative International character just as it was getting into its stride. By that date the International bodies and all the relative units within the compass of the executive staffs then collected were fulfilling the duties assigned to them.

The International Rubber Research Board and the International Rubber Propaganda Committee had met in France, Holland and England, and the Directors of Research and officers responsible for Propaganda had followed a schedule of frequent meetings in the three countries in rotation, as a result of which the activities current under the auspices of the Rubber Growers' Association and the International Association, Holland, had been sifted and decisions come to as to continuity and development. New projects and staffs necessary to handle them had been discussed and co-ordinated programmes preserving necessary flexibility were being worked out. The British Research Unit had made plans for the erection of laboratories contiguous to new ones projected by the Research Association of British Rubber Manufacturers; the Netherlands Unit had decided to rebuild and re-equip in Amsterdam, and the French with the co-operative help of her sister organizations had become installed in well-equipped laboratories in Paris.

The consolidated programmes of research which had been built up gradually had emerged with a bias towards fundamental research, the British Unit having stressed this as being an indispensable preliminary to the likelihood of dis-

National Governments

(Cess collections instituted 1 Oct. 1936)

International Rubber Regulation Committee

(1) International Rubber Research Board

(Constituted 4 June 1937)

RESEARCH

(2) British Unit
British Rubber Research Board (Constituted 8 April 1937)
Incorporated as The British Rubber Producers' Research Association (27 Jan. 1938)

(3) Netherlands Unit
Rubber Foundation (Stichting), Amsterdam. (Incorporated Oct. 1936) and including the Rubber Department of the West Java Experiment Station.

(4) French Unit
Institut Français du Caoutchouc, Paris (Incorporated Oct. 1936).

PROPAGANDA

(5) International Rubber Propaganda Committee
(Constituted 27 June 1937)

(6) British Unit
The British Rubber Publicity Association (Constituted April, 1938)

(7) Netherlands Unit
As for research.

(8) French Unit
As for research.

As to research (2), (3) and (4) integrate programmes and satisfy (1) as to co-ordination, and as to propaganda (6), (7) and (8) integrate programmes and satisfy (5) as to co-ordination and (1) as to finance.

covering clues to large scale new uses and to the possibilities of modifying the raw product including the directions in which certain synthetic materials were showing advantages and which contemporary developments in Germany — of which the Netherlands Units had first hand knowledge — had accentuated. In brief the programmes for 1940, which is the latest period for consolidated records, were those indicated in Appendix (*iii*).

Possibilities of continued collaboration with Holland and France were suspended from June 1940. In 1941, however, the Royal Netherlands Government sequestrated the Rubber-Stichting, Amsterdam, then in occupied territory and reconstituted it as the Netherlands Indies Rubber Research Institute, Buitenzorg, absorbing the Rubber Department of the West Java Experiment Station. Thus the fabric of British/Netherlands collaboration was preserved. This continued until Japan invaded Java. Fortunately a partial preservation of the International character of the scheme was made possible by the close contact which the Board of the British Research Unit has been able to maintain with the scientific officers of the Royal Netherlands Government in London, and by the attendance of an officer of that Government at the meetings of the British Board.

These events brought added responsibilities to the British Board, who, anticipating delay and rising costs of building, decided to rent and equip modern factory premises readily convertible to laboratories at Welwyn Garden City, Herts. By the end of 1941 they had completed their equipment in its main essentials, had consolidated their research team, and concurrent with the pursuit of their own research programme had been able to undertake special work of direct value to the war effort.

Coincident with the termination of the period to which this note relates, the cessation of rubber supplies from Malaya and the Netherlands East Indies resulted in an insistent drive in the U.S.A. for the mass-production of synthetic materials, carrying with it the mobilization of possibly the greatest concentration of research talent on any single problem in industrial science. What may emerge therefrom directly or indirectly in its effect on the plantation industry remains to be seen. The British Unit accepts its new responsibilities and is doing useful work in helping various Government Departments to deal with urgent service problems; it is however also keeping in view the time when the Plantation Rubber areas now under Japanese domination will again be freed, and when international co-operation can be resumed to further the work for which the Research organizations were established.

Meanwhile the list of publications dealing with fundamental research undertaken by the British Unit, given in Appendix (*ii*) will serve to indicate the range and scope of results attained to date till the fuller records of their Netherlands and French colleagues are available.

On the Propaganda side the British Rubber Publicity Association shortly after the outbreak of the war, and having released its senior executive officer for active service, moved to Croydon in offices proximate to the Research Association of British Rubber Manufacturers, and took over a section of the "Enquiries" work connected with the substitution of materials rendered unavailable in normal rubber processing.

The Association subsequently returned to 19 Fenchurch Street, and having seconded its remaining executive officer to the Ministry of Supply for rubber salvage work, is awaiting more propitious times to resume its activities.

**Finance:** — As mentioned previously, the funds visualized as being necessary to place the consolidated scheme on a sound basis were of such order as to meet average annual outgoings of £100,000 for a period of not less than 10 years.

The agreement to implement cess collections on permissible exports had incidence from 1st October 1936 and as from that date constituted part of the main instrument governing the regulation of production and export due to expire on 31st December, 1938. The renewal of this instrument to 31st December 1943 thus guaranteed the proceeds of cess collections for a period of 7

years and three months, and the scheme was launched on that basis with the safeguard that responsibility was placed on the International Rubber Research Board to advise the subscribing governments through the International Rubber Regulation Committee on the necessity to adjust the rate of cess in harmony with the requirements of the scheme.

The International Rubber Research Board had no occasion to seek such an adjustment since the financial position of the constituent organizations was further strengthened by the receipt from the International Rubber Regulation Committee of substantial sums accruing to that body from French Indo-China under Article 6 of the Inter-governmental Agreement, and since, as evidenced in Appendix (*iv*), the average income from cess collections very closely approximated the target of £100,000 p.a.

Under peacetime conditions accounts from the Netherlands and French organizations for the previous year would be presented to the International Rubber Research Board by the middle of the year. The invasion of the Netherlands and France in May and June 1940, precluded the receipt of accounts for 1939 and though cess collections in French Indo-China and the Netherlands East Indies no doubt continued until dates approaching occupation by the Japanese, namely 8th December, 1941 and 7th March 1942, accurate information is not available. In the presentation of an overall statement it has therefore been necessary to compute data for French Indo-China and the Netherlands East Indies after 1938. The table shows that over the period 1st October 1936 to 31st December 1941 (British Malaya was occupied 15th February 1942) the British organizations received in the aggregate £556,500. — 80% to Research and 20% to Propaganda — and making allowances for computations the Netherlands and French organizations had collected sums of the following order — £403,500 and £60,000.

The funds entrusted to the British Research Board have been conserved to ensure continuity of the scheme within the present annual limits of expenditure, for a period of 10 years. The British Propaganda Unit has similarly conserved its funds.

**Summary:** — In the foregoing a brief outline has been given of the reasons which led producers of plantation rubber to consider the necessity of broadening the basis of consumption research and propaganda and how it became possible under the aegis of the "Inter-governmental Agreement to regulate the Production and Export of Rubber 1934" renewed in 1938, further to give effect to the spirit of co-operation which made that instrument possible to formulate and finance a comprehensive scheme with a bias on fundamental research, on International lines.

Steps in the evolution of the scheme involving the absorption of current dispersed activities of producers in the fields of consumption-research and propaganda and bringing them into a more comprehensive co-ordinated plan have been indicated.

It has been related that the plan emerged as autonomous British, Netherlands and French research and propaganda organizations working to a co-ordinated programme and presenting consolidated reports to the signatory Governments of the 1934 Agreement. An indication of the range of activities then in course of evolution, as presented by programmes of work under way to the end of 1940 and by some of the research results already published, has been given.

Funds which have been placed at the disposal of those responsible for administering the scheme have been shown to be of the order of £1,000,000 to the end of 1941.

While under normal conditions it would be far too early to attempt an appraisal of the success of the undertaking and while its dismemberment has set the clock back considerably, the organization made possible by the 1934 Agreement is capable of reconstruction after the war and thanks to the continuity of work conducted by the British Rubber Producers' Research Association should then be able rapidly to make up leeway.

Throughout the intervening period the British Unit will consider itself the trustee for the co-operative organization set afoot and for its objective to increase the industrial eminence of plantation rubber. Already the broad gauge of its work is attracting attention in the U.S.A. and members of its staff have established contacts with leading scientists there in their particular fields: liaison with the available Netherlands scientists is active and intimate despite the stress of the times, and valuable ground work is being covered.

*Appendix* (*i*): **The Constituent Units of the Organization:** —

*International Rubber Research Board.* — Elected by the British Rubber Research Board, afterwards legally constituted as *The British Rubber Producers' Research Association:* Mr. H. ERIC MILLER, Sir FRANK STOCKDALE, and Mr. W. J. GALLAGHER.

Elected by the *Netherlands Rubber Research Board*, legally constituted as *De Rubber-Stichting*, Amsterdam: Jonkheer Mr. W. J. DE JONGE, Prof. Dr. L. P. LE COSQUINO DE BUSSY, Prof. Dr. G. VAN ITERSON, Jr. with Dr. P. J. H. VAN GINNEKEN as alternate.

Elected by the *French Rubber Research Board*, constituted as *Institut Français du Caoutchouc*, under the legally constituted parentage of the *Union des Planteurs de Caoutchouc en Indochine:* M. PHILIPPE LANGLOIS, and Professor LOUIS BLARINGHEM.

The Board elected Mr. H. ERIC MILLER and Jonkheer Mr. W. J. DE JONGE as Chairman and Vice-Chairman respectively, and appointed Mr. G. E. COOMBS as Secretary, with offices at 19 Fenchurch Street, London, E. C. 3.

*International Rubber Propaganda Committee.* — Chairman of the Committee, appointed by the International Rubber Research Board: Mr. H. ERIC MILLER.

Nominees of the Rubber Growers' Association (Incorporated): Mr. JAMES FAIRBAIRN, and Mr. F. E. MAGUIRE.

Nominees of the Netherlands Rubber Research Board (Rubber-Stichting, Amsterdam): Jonkheer Mr. W. J. DE JONGE, Dr. P. J. H. VAN GINNEKEN, with Prof. Dr. G. VAN ITERSON, Jr. as alternate.

Nominee of the French Rubber Research Board (Institut Français du Caoutchouc, Paris): M. P. PETITHUGUENIN.

Jonkheer Mr. W. J. DE JONGE was elected Vice-Chairman and Mr. G. E. COOMBS was appointed Secretary, with offices at 19 Fenchurch Street, London, E. C. 3.

*National Research Units:* —

*British Rubber Research Board* (1937), The British Rubber Producers' Research Association (1938). — Appointments by His Majesty's Secretary of State for the Colonies: Mr. H. ERIC MILLER, Sir FRANK STOCKDALE, Professor W. N. HAWORTH, and Professor E. K. RIDEAL.

The Board elected Mr. H. ERIC MILLER and Sir FRANK STOCKDALE as Chairman and Vice-Chairman respectively, and appointed Mr. G. E. COOMBS as Secretary, with offices at 19 Fenchurch Street, London, E. C. 3. Mr. J. WILSON, M.C., M.Sc., was appointed Director of Research.

Nominees of the Rubber Growers' Association (Incorporated): Mr. P. J. BURGESS, and Mr. W. J. GALLAGHER.

*Netherlands Rubber Research Board.* — Nominees of His Excellency the Governor-General of the Netherlands East Indies and representing: — Raden Adipati Ario SOEJONO (Vice-President), and Prof. J. VAN GELDEREN.

The Netherlands Organization for Applied Science Research: Prof. Dr. G. VAN ITERSON, Jr.

The Colonial Institute: Prof. Dr. L. P. LE COSQUINO DE BUSSY.

Nominees of International Rubber Association: Jonkheer Mr. W. J. DE JONGE (President), Mr. J. C. S. KASTELEIJN, Mr. P. VAN LEEUWEN BOOMKAMP and Mr. P. H. B. VAN GROIN SOETERS.

The Board appointed Mr. W. R. BENZ as Secretary, with offices at Heerengracht 182, Amsterdam.

Dr. A. VAN ROSSEM was the Board's first Director of Research: Dr. R. HOUWINK was later appointed as Director General of Research and Propaganda.

*French Rubber Research Board.* — Hon. President: Professor JEAN PERRIN. President: M. PHILIPPE LANGLOIS (alternate French Delegate to the I.R.R.C.).

Representative of His Excellency Governor-General, Indo-China: M. H. GOURDON.

Representatives of Union des Planteurs de Caoutchouc en Indochine: Monsieur P. PETIT-HUGUENIN and Monsieur M. BOS.

Representative of Syndicat des Planteurs de Caoutchouc de l'Indochine: Monsieur P. BLANCHARD.

Representative of Research Consultative Committee: Professor CH. DUFFRAISSE.

The Board appointed Dr. L. ENDERLIN as Secretary, with offices at 43 Boulevard Malesherbes, Paris.

*National Propaganda Units:* —

*The British Rubber Publicity Association.* — Nominees of the Rubber Growers' Association (Incorporated) on the International Rubber Propaganda Committee: Mr. JAMES FAIRBAIRN, and Mr. F. E. MAGUIRE.

Other Members: Mr. E. JAGO, Mr. A. C. MATTHEW, and Mr. F. G. SMITH.

The Board elected Mr. JAMES FAIRBAIRN and Mr. F. E. MAGUIRE as Chairman and Vice-Chairman respectively. Mr. G. S. COOK was appointed Secretary, with offices at 19 Fenchurch Street, London, E. C. 3.

*Netherlands Propaganda Unit.* — First Director: Ing. J. G. FOL.

*French Propaganda Unit.* — First Director: M. L. DE MONGEOT.

*Appendix* (*ii*): **Interim Short Title List of Publications emanating from the Laboratories of the British Rubber Producers' Research Association, on work conducted to the end of 1943:** —

"Elastic Recovery and Plastic Flow in Raw Rubber."

"The Proteins of Hevea Brasiliensis."

"Fractionation of Rubber."

"The Molecular Weights of Rubber and Related Materials" — I. Experimental Methods.

"The Molecular Weights of Rubber and Related Materials" — II. Osmotic Pressure and Viscosity of Solutions of Raw Rubber.

"Relation between Molecular Weights and Physical Properties of Rubber Fractions."

"Crystallisation Phenomena in Raw Rubber."

"Analytical Methods in Rubber Chemistry" Part I.

"The Kinetics of the Polymerisation of Isoprene on Sodium Surfaces."

"The Proteins of Hevea Brasiliensis." II. Analysis of a Product Isolated from Crepe Rubber.

"Studies in the Sterol Group." XLIII. The Unsaponifiable Portion of the Acetone Extract of Plantation Rubber.

"Analytical Methods in Rubber Chemistry." IV. The Determination of Peroxidic Oxygen.

"The Number of Configurations of a Co-operative Assembly."

"The Molecular Weights of Rubber and Related Materials." III. A Correction of Part II; IV. The Micellar Theory of the Structure of Rubber.

"Rubber, Polyisoprenes, and Allied Compounds." I. The Synthesis of Low-Molecular Polyisoprenes of the Rubber and the Squalene Type.

"The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds." I. The Structure and Reactive Tendencies of the Peroxides of Simple Olefins.

"The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds." II. Hydroperoxidic Structure and Chain Scission in Low-Molecular Polyisoprenes.

"The Autoxidisability of the Alkyl Groups in Xylene."

"The Interaction Between Rubber and Liquids." I. A Thermodynamical Study of the System Rubber-Benzene.

"The Caoutchol Component of Natural Rubber." A correction.

"Analytical Methods in Rubber Chemistry." V. Estimation of the Oxygen of Highly Autoxidised Rubber contained in Carboxyl, Ester, Carbonyl, Epoxide and Hydroxyl Groups.

"The Phosphatides of Hevea Brasiliensis."

"Thermodynamic Study of the Elastic Extension of Rubber."

"The Interaction Between Rubber and Liquids." II. The Thermodynamical Basis of the Swelling and Solution of Rubber:—

(*i*) -Methylenic Reactivity in Olefinic and Polyolefinic Systems.

(*ii*) The Course and Mechanism of Autoxidation Reactions in Olefinic and Polyolefinic Substances, including Rubber.

(*iii*) Ionic and Radical Mechanisms in Olefinic Systems, with special reference to Processes of Double-Bond Displacement, Vulcanisation and Photogelling."

"Rubber, Polyisoprenes, and Allied Compounds." II. The Molecule-linking Capacity of Free Radicals and its Bearing on the Mechanism of Vulcanisation and Photogelling Reactions.

"The Interaction between Rubber and Liquids." III. The Swelling of Vulcanised Rubber in Various Liquids.

"The Crystal Structure of -Isoprene Sulphone."

"The Elasticity of Network of Long-Chain Molecules. I."

"The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds." IV. The Isolation and Constitution of Photochemically-formed Methyl Oleate Peroxide.

V. Observations on Fish-Oil Acids.

"The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds." VI. The Peroxidation of Rubber.

"The Vapour-Pressure Equations of Solutions and the Osmotic Pressure of Rubber."

"Characteristics of Wild Rubbers."

"Why is Rubber Elastic?"

"Interaction between Rubber and Liquids." IV. Factors Governing the Absorption of Oil by Rubber.

"Rubber, Polyisoprenes, and Allied Compounds." IV. The Relative Tendencies towards Substitutive and Additive Reaction during Chlorination.

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"The Statistical Length of Paraffin Molecules."
"The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds." Part VII. Rearrangement of Double Bonds during Autoxidation.

*Appendix (iii):* Research and Propaganda Programmes 1940:—

| | British | Netherlands | | French |
|---|---|---|---|---|
| | | Holland | West Java | |
| **1. Research:—** | | | | |
| *Fundamental.* | | | | |
| Oxidation of rubber | x | | | |
| Hydrogenation of rubber | x | | | |
| Fundamental factors governing oil absorption | x | | | |
| The atomic structure of rubber | x | | | |
| The factors governing the equilibrium state of solutions of rubber | x | | | |
| The effect of light on rubber | x | | | x |
| The non-rubber constituents of commercial rubber | x | | | |
| Polymerization | x | x | | |
| Research on synthetics | x | x | | |
| Vulcanization | | x | | |
| Freezing raw and vulcanized rubber | x | x | | |
| Elasticity and plasticity | x | x | | |
| Sound and vibration absorption | | x | | |
| Swelling of rubber | x | x | | |
| The process of coagulation | | | | x |
| Spectrography | | | | x |
| Research on colloidal chemistry of latex | | | x | |
| *Applied.* | | | | |
| Positex | x | | | |
| Latex thickening and pastes | | x | | |
| Rubber powders | | x | | |
| Direct use of raw coagulum | | | | x |
| Attachment of rubber to metal | | x | | |
| Heat sensitive latex | | x | | |
| *Development.* | | | | |
| Commercial development of rubber resins | x | | | |
| Expanded chlorinated rubber | x | | | |
| Rubber/resins moulding powders | x | | | |
| **2. Propaganda:—** | | | | |
| Agriculture | x | x | | x |
| Building industry | x | | | |
| Railways | x | | | |
| Roadways (rubber/asphalt) | | x | | |
| Engineering | x | | | |
| Noise abatement | x | x | | x |
| Rubber in the home | x | | | |
| Synthetic rubber (collection of data) | | x | | |
| School educational scheme | x | x | | x |
| Military purposes | | | | x |
| Dissemination of research results | x | x | | x |
| Propaganda in Belgium, Scandinavia and Argentina | | x | | |
| Propaganda in rubber in agriculture in America | x | | | |

*Appendix (iv):* **Income accrued to the End of 1941** (expressed in £ sterling):—

| Period | Cess Collections | | | | French Indo-China: Art. 6 of Inter-Governmental Agreement | | | |
|---|---|---|---|---|---|---|---|---|
| | British | Netherlands | French | Total | British | Netherlands [2] | French | Total |
| 1.10.1936 to 31.12.1936 | 11,000 | 8,000 | 1,500 | 20,500 | 43,000 | 31,000 | 2,500 | 76,500 |
| 1937 | 55,500 | 40,000 | 4,000 | 99,500 | 62,000 | 46,000 | 4,500 | 112,500 |
| 1938 | 39,000 | 27,500 | 5,500 | 72,000 | 112,000 | 84,000 | 9,000 | 205,000 |
| 1939 | 44,000 | 31,000 [1] | 6,500 [1] | 81,500 [1] | 59,000 | 42,000 [1] | 8,000 [1] | 109,000 [1] |
| 1940 | 67,000 | 48,000 [1] | 9,500 [1] | 124,500 [1] | | | | |
| 1941 | 64,000 | 46,000 [1] | 9,000 [1] | 119,000 [1] | | | | |
| | 280,500 | 200,500 [1] | 36,000 [1] | 517,000 [1] | 276,000 | 203,000 [1] | 24,000 [1] | 503,000 [1] |

[1] Computed.
[2] Paid to Rubber Crisis Centrale, Java: the organization for the collection of various cess collections levied in respect of N.E.I. Rubber.

# THE WORK OF THE WEST JAVA RESEARCH INSTITUTE IN BUITENZORG


*by*

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The West-Java Research Institute is a private institution serving all the tea plantations of the Netherlands Indies (138,000 ha.[1]), cinchona cultivations to the extent of over 17,000 ha., and the rubber plantations of the western half of Java and South and West Sumatra (160,000 ha.).

The work of the Institute embraces fundamental botanical and chemical research and plant selection, besides special agricultural, technical, and phytopathological studies of more or less local problems, and advisory work. I shall confine myself here to a consideration of the more general and fundamental researches.

## TEA

1. *Botanical investigations.* — Dr. IZ. DE HAAN has been engaged in a study of the anatomy of the tea plant and published a first paper on the stem and leaf in 1939 [1]. Leaves from plantations at high altitudes are thicker and stronger than those from low-lying plantations.

Transpiration of tea shoots (bud and fourth leaf) was particularly high in the morning [2], although the moisture-content of the leaf remained fairly constant throughout the day. The stomata are open to the greatest extent in the morning hours, but close rapidly with the fall in the rate of transpiration when the leaves are plucked. An average bud-and-fourth-leaf shoot weighing 3.37 grams evaporated 1.5 gm. of water per hour in the morning. The temperature of leaves exposed to the sun was several degrees above the air-temperature, but fell 1 to 2° C. in the shade, owing to evaporation.

Deficiency symptoms in tea have been studied by means of sand and water cultures [3]. Growth is greatly retarded by nitrogen deficiency, the leaves are small and light yellow in colour, and dormant buds predominate so that few new leaves are formed. Sulphate deficiency also causes retardation of growth and yellowing of leaves, but the ratio of dormant to growing buds is normal (1:1). With phosphate deficiency the leaves are dark green to dull blue green, whilst magnesium deficiency causes a light-yellow coloration of the old leaves except for the parenchyma along the nerves, which remains green. Symptoms of calcium deficiency are most noticeable on half-grown leaves; the colour is normal with light green at the leaf edges, and cessation of growth of the nerves causes the leaves to bend.

A separate study of potash deficiency, which is widely distributed in West Java and West Sumatra, has appeared [4]. The leaves of the lower branches fall off, and the old leaves go dark brown at the edges and die. Deficiency symptoms occur on soils with less than 0.007 per cent. potash soluble in 25 per cent. HCl. The ash of potash-deficient (old) leaves usually contains less than 10 per cent. $K_2O$, as against 20 per cent. in normal leaves. Heavy applications of sulphate of potash eliminate the deficiency symptoms and bring production up to normal.

Vegetative reproduction of tea is of great importance for selection, and methods have been devised with a view to securing rapid multiplication. The usual method of budding requires bud-wood several years old. More rapid methods include whip grafting [5] and propagation by cuttings [6, 7]. In whip grafting, a young, green scion shoot from which a strip of bark 2–3 mm. wide has been removed is placed sideways against a stock stripped of a similar width of bark. After about 10 days the bark of the stock is ringed just above the graft. When the bud has swollen, the stock can be removed above the graft; 80–90 per cent. of such grafts are successful.

Propagation by cuttings can also be very successful if the light, temperature, and moisture relationships are carefully controlled in the seed-boxes, which are cooled with running water. Treatment of cuttings, before setting out, with hortomone-A solution (1:240) has had good results, but heteroauxin, which was quite effective in 1939, was ineffective in 1940, probably owing to deterioration of the product.

Hand-pollination is a most valuable aid in selection work. In the field of floral biology the following observations have been made [8]. The period from flowering to ripening of fruit at Buitenzorg is about 8 months. Twenty-four hours after the bud has opened, the corolla and stamens begin to fall off, and the process is completed in 3 days. The presence of the corollas greatly encourages the visits of insects, and their removal before the flower-buds open practically prevents all pollination. The technique of crossing therefore consists in separating the corollas from the stamens before the buds open, and in pollinating the stigma-lobes with the pollen of the male plant. Closure of the pollinated bud is unnecessary; by this means seed with a germinating power of about 15 per cent. has been obtained.

2. *Selection.* — Purposeful selection of tea in Java dates only from 1915. The early selections of types were done by eye, but a system gradually developed of selection according to productivity based on pluckings from individual bushes. This system has been perfected by WELLENSIECK [9]. In all, about a million plants were judged by eye, from which about 44,000 were selected by individual pluckings. From these, 2100 mother trees were finally selected from the majority of which clones were made.

For determining individual production five or six test pluckings, which in this case are made in one year, are sufficient. The requirements which must be satisfied by a mother tree are: a minimum yield of 50 gm. of moist leaf per plucking; production at least three times that of all the

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[1] 1 hectare = 2.47 acres.

original material, and a number of mother trees amounting to not more than 1 per cent. thereof; the desired type and a constant yield.

In this way clones were selected with yields 100 per cent. greater than those obtained from ordinary nursery stock. A large scheme is in operation for the local testing of clones in replicated experimental plots.

A number of artificial crossings between selected clones has recently been carried out; the seedlings therefrom will also be tested. It has already been clearly shown that the progeny of high-yielding clones produce more than ordinary seedlings.

3. *Chemistry of tea.* — Dr. W. B. DEIJS has been studying the chemistry of tea and tea preparation for 5 years.

The young green leaf used in preparing black tea contains in the dry matter 20–33 per cent. of tannins, of which 16–30 per cent. is insoluble in gelatine. The greater part of the tannins can be obtained only in an amorphous state, and consists largely of a gallic ester of catechin. There has also been separated 0·1–0·15 per cent. of crystalline tea-catechin, up to 0·3 per cent. of the gallic ester of tea-catechin, and 0·1–0·4 per cent. of gallo-catechin. The changes undergone by these tannins during the preparation of the tea have a great influence on the quality of the product, particularly on the colour of the infusion.

During withering the green leaf loses 20–30 per cent. of water, and becomes supple and easily rolled. At the same time, starches are hydrolysed, whilst proteins are more or less decomposed and the activity of various oxidizing ferments, of which catalase and peroxidase are the most important, increases. During the first hour of fermentation the activity of the oxidizing ferments greatly decreases as a result of chemical reactions caused by the mixing of the leaf-juices, and the colour of the leaf turns brown. High temperatures also inactivate the ferments. Drying fermented tea *in vacuo* at room-temperature increases the activity of those ferments which effect the oxidation of tannins. Loss of tannins occurs during rolling and the subsequent fermentation and drying; of the tannins remaining in the black tea, 40–50 per cent. are extracted in the infusion.

4. *Preparation of tea.* — The results of several extensive inquiries undertaken by different tea concerns from 1936 to 1941 have been collated and published [10, 11]. Studies have also been made on the deleterious effect of prolonged withering on the quality of tea [12]; on the effect of elevation of plantation and factory on quality [13], showing that preparation in a factory at a high altitude was generally beneficial, whilst the leaf from a highly situated plantation was of appreciably better grade than lowland leaf; and on the grading of rolled leaf and the machinery used for it [14].

5. *Agricultural investigations.* — The first pluckings after pruning, the different plucking methods, and the length of the plucking cycle have been the subjects of many experiments [15, 16]. In a lowland plantation a lengthening of the plucking cycle from 3–4 to 10–11 days increased the amount of commercial leaf in a coarse plucking and reduced it in a fine plucking. The duration of the plucking cycle will thus vary with the nature of the pluck. The quality of the product falls when the plucking cycle is prolonged.

Two papers on planting distances [17, 18] have shown that production from a tea plantation is higher during the first 10 years the closer the planting. Subsequently yields level out, but with heavy fertilizing closely planted gardens maintain their supremacy. Thinning of closely planted gardens according to the productivity of individual bushes is not generally practicable, and thinning by eye probably has little influence on total production.

A number of fertilizer experiments with sulphur, which greatly increased the acidity of the soil and the availability of soil minerals, showed that sulphur appreciably increased the growth of the bushes and, in many cases, the production over several years [19]. Sulphur applications are particularly successful on young volcanic soils with $p$H over 5. Liming, on the other hand, is harmful.

A large number of fertilizer experiments has made possible a classification of West-Javan tea soils according to fertilizer requirement [20]. In general, organic nitrogen (oil-cake) is less effective than inorganic. The normal optimal fertilizer application for fully grown tea gardens is 300–500 kg. of sulphate of ammonia and 100 kg. of double superphosphate per hectare per year (2·4–4·0 and 0·8 cwt. per acre, respectively).

6. *Plant-pathological investigations.* — The most serious insect pest of tea in Java is *Helopeltis*, against which a very effective and economic counter-measure has been found in the dusting of gardens with derris powder [21]. Canker of the branches is a common, but not invariable, result of the lesions made by *Helopeltis* in shoots and branches.

On the mycological side much attention has been paid to various root-fungi. The red root-fungus *Ganoderma pseudoferreum* can be effectively controlled by isolating and digging up attacked bushes; the determining factor here is the cost. No satisfactory control has been discovered for the black root-fungus (*Rosellinia arcuata*), which is possibly disseminated by spores as well as by root-contact underground. Another red root-fungus *Poria hypolateritia* and 'bitten-off' disease, caused by a species of *Pythium*, have also been studied [22, 23].

## RUBBER

Owing to lack of staff, publication of the results of many rubber investigations is much in arrears and references to the literature cannot often be given.

1. *Botanical investigations.* — A series of investigations has been made of deficiency symptoms which are externally similar to those of tea. With phosphate deficiency, the leaves are a darker green, with the older ones tinted brown-red, and stiffer than normal. Incomplete N-P and sulphate nutrition greatly checks growth in both length and thickness.

*Hevea* seedling plants can be divided [24]. The 'twins' so obtained grow normally and display identical characteristics of growth and production, thus making it possible to carry out strictly comparable experiments. Several such plants were budded with a certain clone, whilst the twin plants were grown as unbudded seedlings. Budded plants on high-yielding root-stocks gave considerably higher production than on low-yielding stocks (arranged according to the productivity of the twin plants).

The mutual influence of stock or scion on the performance of the other has also been shown

in other ways, but the relationships between the two are still very complex. There is much diverse evidence that self-budding has no effect on growth or yield. Attempts to propagate *Hevea* by cuttings have usually failed.

2. *Selection.* — Selection of *Hevea* has doubled and trebled the yields of old estates. In the last 10 years a definite 'ceiling' seems to have been reached. The clone Tjirandji I, which was put on the market in 1928, is still one of the highest yielders.

Nevertheless a great deal of work has been done to improve other qualities, especially resistance to bark diseases, wind damage, &c. The West-Java Station performs 50,000 crossings between the best clones every year, with an average success of about 5 per cent. These seedling families are tested for yield while at the same time they are serving as material for further selection of superior mother trees.

The seedling families of good clones also seem to be good yielders, although they have not reached the level of the highest-yielding clones. They are, however, as susceptible as the older clones to bark diseases and have other undesirable qualities, and require just as much nurturing. There are also possibilities of raising yields by selection of the seed-bed by the 'testatex' or other method of determining the flow of latex, and subsequently in the growing plantation by selective thinning on a yield basis.

Since newly selected material needs local testing of its reaction to local factors, particularly climate, soil type, and altitude, a large and increasing number of local trials have been made. At the end of 1940 the West Java Station had charge of 32 local trials and 3 experimental rubber plantations of about 300 hectares.

An arrangement was made in 1940 with stations in Ceylon, Malacca, and Sumatra for the exchange of promising new material so that a wider basis of selection could be secured.

3. *Chemistry.* — A great many papers have been published in the *Archief voor de Rubbercultuur* on the chemistry, physics, and technology of rubber latex. Without referring specifically to these, it may be said that the main lines of research have been on the physical and chemical properties of latex and rubber, the bacteriology of the rotting process, possibilities of modifying the rubber molecule, technical applications of rubber, the conservation and creaming of latex, and the effect of different processes on the properties of rubber.

4. *Preparation of rubber.* — In recent years there has been a noticeable development in smoking- and drying-sheds in the direction of 'tunnel' sheds. By improved insulation and air circulation the drying-time could be considerably shortened in many crêpe drying-sheds.

Recent research has shown that wet sheets can be completely smoked in a few hours and can afterwards be rapidly dried. In this way the total time of smoking and drying can be compressed into two days.

Packing rubber in three-ply boxes is costly and unnecessary Methods have been developed for packing sheet rubber in gunny or in other sheets [25], but it remains to be seen whether these cheap and adequate methods are acceptable to the consumer.

Rubber mould can be prevented by the use of disinfectants, especially paranitrophenol, but a better way is to keep the relative humidity of the atmosphere in the packing-shed below 70 per cent. [26].

The question of coagulator assumes importance in war-time. A bacteriological method of preparing acetic acid from latex serum and spirit has been worked out [27], and has been tested by several concerns. Coagulation with sulphonated oil has also been shown to be feasible, and the method is under investigation [28].

5. *Agricultural investigations.* — One of the most important problems is to raise the productivity of old plantations up to modern standards. Prolonged experiments with the 'two-cut' tap (one made 60–80 cm. above the other) and with the 'high' tap (with a second cut at 2–3 metres height) indicate that yield-increases of 20–40 per cent. can thereby be obtained for several years [29]. Another method of increasing production, at any rate in places where labour is abundant, is to reduce the tappings from, say, 320 to 160 trees, so that tapping can be completed in the early morning. The more careful work that is thus possible also helps to increase yields.

A test of different tapping systems that has gone on continuously for 15 years has given the following results [30]. The yields from the more intensive system (S/2, d/2, 100%) [2] were about 15 per cent. higher than from the lighter systems (S/3, d/2, 67%).[3] Period tappings for 20–30 days gave yield increases of 7 per cent. and 4 per cent. over tappings on alternate days. Brown-bast attacks have been highest with the intensive tapping systems, but it has been found that by halving the length of the cut attacked trees can be maintained in regular production.

A large number of fertilizer trials has shown that on certain soil types a complete NPK fertilizer gives excellent results, on other types only NP is effective, and on yet other (rich) soils no fertilizer response is obtained. On stiff, impermeable soils the construction of blind drains, which are filled with loppings from the vegetation, have appreciably increased yields over considerable periods.

The Research Station has evolved a system of spacing and thinning budded plantations, whereby at first 400–500 trees are maintained per hectare, and a thorough and rapid thinning is made at the end of the fifth year so that by the eighth year the number of trees is reduced to abour 270 per hectare. This number is then gradually reduced to 180. Large numbers of stems in the early years give higher yields, but bark renovation is less satisfactory.

Since rubber is planted in the Netherlands Indies up to an altitude of 700 metres, it is interesting to compare its behaviour in the plains and in the elevated plantations [31]. Growth of the same clones under similar soil and climatic conditions was slower at 515 metres than at 250 metres altitude. The criterion of tapability (45 cm. girth at 1/2 metres height) was also reached 2 years later, and susceptibility to brown bast was greater, at the higher altitude. Production, however, was about the same.

A comparative test of topping at 3–5 metres height young rubber trees that had not formed side branches showed that topping first increases, but subsequently reduces, density of growth.

6. *Plant-pathological investigations.* — Root-

[2] *i. e.* a half-spiral cut tapped every other day.

[3] *i. e.* a third-spiral cut tapped every other day at 67 per cent. of the intensity of the standard S/2, d/2 system.

fungi are the chief pests of rubber plantations. The white root-fungus *Fomes lignosus* occurs everywhere in young, and also in older, plantations. In young plantations where the roots of separate trees do not touch, control by removal of affected trees is effective, but in old plantations the root-necks of neighbouring trees must be exposed. Careful removal of root-residues in clearings is necessary, as isolated roots can continue to live in the ground for several years. The fungus spreads more rapidly through clean-weeded ground than under a cover of *Centrosema pubescens*.

The red root-fungus *Ganoderma pseudoferreum* occurs in the heavier soils and attacks older trees. The infection comes mostly from *Albizzia falcata*, which greatly favours the spreading of this fungus. Exposure of the root-necks gives effective control.

## CINCHONA

The results of cinchona investigations are circulated only to interested parties, and therefore no literature references are given.

1. *Botanical investigations.* — Monthly analyses of bark have shown that the quinine-content undergoes periodical fluctuations during the year. In a 16–years' study, an increase in the quinine-content of clones was observed in the early years, but in unmanured plantations a decline set in about the fifth to seventh year and persisted with irregular variations. Manuring, however, maintained the quinine-content or reduced the rate of decline. Different clones behaved differently.

The quinine-content of the bark from the same seedling variety or clone varies according to the soil and environmental conditions. A high content is found where vertical growth is stunted. In these areas *Helopeltis* attacks are common, which further restrict growth and increase the quinine-content.

The quinine-content of the underground bark of the *Succirubra* stock of the graft depends on that of the overground bark. The content of the root-bark is 1·158 times that of the overground bark raised to the power 0·46.

2. *Selection.* — Selection of cinchona was begun shortly after its introduction into Java by selection of mother trees with high quinine-content. The original low content of quinine has been raised to 12–15 per cent., and some clones are known with 17 or 18 per cent. Productive capacity has been doubled or trebled.

The basis of selection is not only the quinine-content of the bark, but also the yield of quinine, which is influenced by the thickness and water-content of the bark and the growth of the tree. Resistance to diseases and pests is also taken into consideration.

Artificial pollination of clones has been very successful. Cinchona is heterostyle, so that only long-styled clones or varieties can be crossed with short-styled. The valuable varieties thus produced give promise of high yields in plantations, besides forming the basis of further selection. A few nurseries have been planted with the desired combination of clones.

3. *Chemistry.* — A method has been devised for determining the quinine-content of small (2 gm.) samples of bark. The micro-chemical detection of bark alkaloids in living tissue has been studied, but without definite results.

When bark is dried at too high a temperature, a partial decomposition of the alkaloids occurs. A method is being devised for determining the loss by decomposition on drying.

The coarser pieces of bark have been found to contain more quinine than does powdery material; consequently samples for analysis must be very carefully prepared.

4. *Agricultural investigations.* — During recent years a method has been worked out in conjunction with the Forest Experiment Station for estimating the stock of bark and quinine in a plantation. The Forest Station constructed locality, class and yield tables, such as are commonly used in forestry, for various clones and varieties. These were supplemented by tables of quinine-content of bark, according to clone, age, and the manurial condition of the land. This work is not yet completed.

A few tests of spacing and thinning have indicated that closely spaced plantations give the highest yields, but there is a wide range in the optimal density of plants.

Analyses of neighbouring patches of soil of varying productivity showed that the productive soils were characterized almost without exception by a high content of organic matter, high nitrogen, and low carbon-nitrogen ratio. They also usually had more citric-soluble phosphate, more lime, and a higher hydrolytic acidity than the less productive soils.

5. *Plant-pathological investigations.*—Cinchona is susceptible to many diseases. Attacks of *Rhizoctonia solani*, which can be controlled with 'superol,' occur in seed-beds, and striped canker caused by a *Phytophthora* is widespread. The black root-fungus *Rosellinia arcuata* is also common. The most serious insect pests are *Helopeltis* and *Pachypeltis*, which can be controlled in young plantations by powdering with derris preparations. There are several harmful caterpillars, but it is found that in serious attacks these are usually parasitized and the attacks come to an end without control measures being taken.


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(*Note.* A.R. = Archief voor de Rubbercultuur. A.T. = Archief voor de Theecultuur. B.C. = De Bergcultures.)

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# A HISTORY OF THE VISITORS' LABORATORY ("TREUB LABORATORIUM") OF THE BOTANIC GARDENS, BUITENZORG, 1884–1934

*by*

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In November 1934 it was exactly fifty years ago that the Foreigners' laboratory of the Government Botanical Gardens at Buitenzorg was founded. This day was not celebrated in any festive manner, owing to the fact that under stress of circumstances the laboratory has no permanent leader just now and had at the time no foreigners working there. Yet I think we cannot allow this date to pass unnoticed, if it were only to honour the man who brought about the existence of the laboratory and thus created one of the most valuable departments of the Botanical Gardens, an institute that has greatly contributed to enhance the glory of the Buitenzorg scientific centre even far abroad.

It is therefore not without reason that in the report of the Botanical Gardens for 1884 TREUB began the chapter about the botanical station with the remark that this new paragraph was likely henceforth to rank among the most important items in his reports. At the same time the hope was expressed that the visits of foreign scientists might not only serve to uphold the glory of the Botanical Gardens but that through them the "Annales du Jardin Botanique" might be enriched with important contributions about investigations made or started at Buitenzorg. These expectations may certainly be said to have been fulfilled.

On November 14, 1884 the buildings of the Military Medical Service at Buitenzorg (situated between the curator's house and the present Zoological Museum) were handed over to the Botanical Gardens and the former hospital-room was made into a botanical station. This old station is the building situated on the West of the square now surrounded by the buildings of the Laboratory for Chemical Investigation. The founding of the station was made known by means of a circular, written in French, in which the great importance of "studying on the spot" and the further advantages offered by the Botanical Gardens were pointed out. On January 10, 1885 the laboratory was opened to visitors.

Thus the first botanical station in the tropics was founded. It was preëminently meant for use by foreign botanists, who wanted to work in the Botanical Gardens. In the above-mentioned report TREUB states, moreover, that it might be reasonably expected that the newly-founded laboratory will attract visitors, since the Botanical Gardens offer an opportunity for botanical study in practically every respect.

Before that date one single foreign scientist, Graf ZU SOLMS-LAUBACH, visited the Botanical Gardens in 1883–84 in order to make certain investigations. His description of the Gardens and his advice to others to visit Buitenzorg have certainly contributed to the fact that soon afterwards many others followed his example.[1]

In the very first year after the foundation no less than five students made use of this new "workshop," although in the old room there were only four tables available. Of these five two were Dutch and three foreigners. The Dutchmen were Dr. S. H. KOORDERS of the Netherlands Indian Forest Service, who was the very first worker to find a place in the new laboratory; the other was Prof. J. F. EIJKMAN, former professor of chemistry and pharmacology at the University of Tokyo. EIJKMAN, who after a nine years' stay in Japan was on his way back to Europe, visited Netherlands India and in the Botanical Gardens carried out phytochemical investigations.[2] No doubt his visit has been the first impulse to the foundation of the Pharmacological laboratory of the Botanical Gardens, which took place in 1888. Of the three foreigners who in this first year worked at the station we mention in the first place Prof. K. VON GOEBEL, at the time professor of botany at the University of Rostock. This well-known botanist, who had primarily intended to make his investigations in Ceylon, changed his plans when he heard of the foundation of the Buitenzorg station and preferred to come to Java. Of the two other foreign-

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[1] Botanische Zeitung, Jg. 42 1884.

[2] J. F. EIJKMAN. [illegible] aan 's Lands Plantentuin te Buitenzorg; 's-Gravenhage, 1887.

ers, both Russians, one was a botanist, the other a zoologist.

It is obvious that from the very beginning this botanical station rightly deserved the name of "foreigners' laboratory" and also, that from the beginning not only botanists but also zoologists and chemists were among its visitors. From the first a laboratory-register was made, in which every visitor wrote a short entry concerning the duration of his stay, together with the principal subjects studied by him.

In order to enable also Dutch botanists to profit by the existence of this laboratory and the other institutes at Buitenzorg TREUB managed to raise, during his stay in Holland, a fund that was to pay for regular trips of botanists to Buitenzorg. By means of this "Buitenzorg foundation"[3] together with a yearly subsidy from the Government the possibility has been created to send a botanist to Buitenzorg every two years. As it was at that date regretted that two years were to elapse before the first Dutch botanist was to go and work at the Buitenzorg station a sum of *f* 2400.— was collected privately to enable one to start for Buitenzorg immediately. Thus Dr. J. G. BOERLAGE, conservator of the National Herbarium at Leyden, could accompany TREUB on his voyage back to Java, in 1888, as the first visitor on behalf of the Buitenzorg foundation.[4]

Through TREUB's untiring attempts means were found also in many other countries to send investigators to Buitenzorg regularly in the course of the following years. One of the first countries which showed activity was Germany and from this country a great number of scientists have until this day visited Netherlands India, so that among the numerous visitors of the Foreigners' laboratory the Germans take a foremost place, not only as to number but also as to the scientific fame of those who visited Buitenzorg. Other countries followed suit; as a rule it was either the Government or the National Academy of Sciences that more or less regularly provided the means for such a voyage and stay in the tropics. Germany was soon followed by Austria, Russia, Belgium and Switzerland.

The Great War has put a stop to this, as it has done to many another ideal or spiritual thing, and the ensuing economical downward progress has prevented many countries from continuing what they had started so enthusiastically.

In 1890 an important extension took place by the foundation of a botanical laboratory by the side of the botanical station, which laboratory was to investigate the conditions of life, anatomy, and diseases of tropical economic plants. The two institutes were placed under one head, as a department of the Botanical Gardens, named "Botanical laboratories." Thus a chief of the Foreigners' laboratory was appointed and the first to take office as such was Dr. J. M. JANSE, who subsequently became professor of botany at the University of Leyden.

The next year was not less important in the history of the Botanical Gardens. After the reservation of a large stretch of primeval forest situated above the mountain-garden of Tjibodas, in 1889, that garden also obtained a botanical station in 1891, where the flora and fauna of the adjoining forest could be studied. The station contained both working and sleeping accommodations for a small number of visitors.

In the next few years the new Botanical laboratory occupied itself practically exclusively with the investigation of plant-diseases whereas the investigation of more particular problems was left to the many foreign visitors who came to work at Buitenzorg or Tjibodas. To what extent this study of the diseases of economic plants predominated is proved by the fact that the said laboratory is often mentioned under the name of Phytopathological laboratory, as *e.g.* in the report on the organization of the Botanical Gardens in 1898 by TREUB (Bulletin No. 1 de l'Institut Botanique de Buitenzorg).

It is selfevident that during the first period the Foreigners' laboratory was still rather primitive; only in the year when the new Botanical laboratory was opened were the buildings provided with gas which was generated from petrol in a private plant. Some years were to elapse before waterpipes were laid (1893), the water being supplied from cisterns in which rainwater was collected. The old gas plant stood on the spot where later on the new Treub laboratory was to arise, and after gasworks had been constructed at Buitenzorg (1902) it was removed to Tjibodas, where it ceased to function after the building of the new laboratory there.

If one considers the unfavourable circumstances under which the first scientists had to work in the tropics, as compared with the many comforts and the superior equipment of present-day laboratories, one can but admire the work that was done in those days.

In 1891 the Foreigners' laboratory was enlarged with one room for making plant-physiological experiments in the dark, while at the same time, owing to the ever greater use made of photography as a means of investigation, a dark room was furnished for the exclusive use of the visitors.

The number of visitors increased steadily and in 1890 amounted to 12. It is evident that four tables were insufficient for so many workers, hence they had often to be accommodated elsewhere. During the first ten years of its existence the Buitenzorg station was visited by 46 people. Of these the greatest number were Germans, sixteen in all. There were 14 Dutch and the others were representatives of practically all European nations, Austrians, Russians, Englishmen, one Belgian, one Dane and one Swede, an international party indeed.

The lack of room was improved when by means of rebuilding the laboratory a fifth and later on a sixth place could be added to the four already existing and when in 1896 a new building was made, which became the seat of the Botanical laboratory, three more tables were here put at the disposal of foreign scholars, whereas one more separate room was reserved for scientists that came for special investigations in the Botanical Gardens. The Botanical laboratory that formerly, together with the office of the Gardens, had been housed in a part of the former hospital, was now established in the east-wing of the build-

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[3] For further particulars see the Report of the Government Botanical Gardens for 1888.

[4] Altogether there have been sent out for the Buitenzorg oundation until 1934 besides Dr. BOERLAGE 21 Dutch students, *viz.* F. A. F. C. WENT (1890), J. C. COSTERUS (1892), E. GILTAY (1895), P. C. PLUGGE (1897), A. H. SCHMIDT (1898), S. L. SCHOUTEN (1901), J. C. SCHOUTE (1903), A. A. PULLE (1906), PH. VAN HARREVELD (1907), J. KUYPER (1910), A. H. BLAAUW (1911), Mej. J. WESTERDIJK (1913), Mej. C. SLUITER (1915), Mej. H. C. C. LA RIVIÈRE (7919), H. BOSCHMA (1920), TH. STOMPS (1923), O. POSTHUMUS (1925), B. H. DANSER (1925), G. L. FUNKE (1927), Mej. B. POLAK (1930), Mej. A. KLEINHOONTE (1932).

ing that had been put in its place and which, later on, was occupied by the Analytical laboratory.

Still more accommodation for foreign workers was obtained when the new Zoological Museum was built in 1901. There a room with three working-tables was reserved as a laboratory for foreign zoologists, who until then had been put up in the Botanical station.

The last zoologist still to enjoy the hospitality of the Botanical station was ERNST HAECKEL from Jena, who also witnessed the institution of a private laboratory for foreign zoologists. This fact gave rise to his writing in the guest book of the Foreigners' laboratory the following words: "Das neue Zoologische Laboratorium, dessen Mauern ich jetzt aus dem Boden wachsen sehe, wird dann auch den Zoologen eine ebenso günstige und unschätzbare Gelegenheit zu anatomischen und physiologischen, ontogenetischen und phylogenetischen Forschungen bieten, wie bis jetzt das Botanische Laboratorium der wissenschaftlichen Pflanzenkunde die grössten Dienste geleistet hat. Indem ich Herrn Professor TREUB den dankbarsten Erfolg für seine aufopfernde Tätigkeit auch in dieser Beziehung wünsche und ihm für seine freundliche und zuvorkommende Unterstützung nochmals den herzlichsten Dank ausspreche, hoffe ich dass das *Biologische Institut* von Buitenzorg noch für lange Zeit das beste Central Institut für das Studium der Tropennatur bleiben und von Europäischen. Naturforschern immer fleissiger besucht werden wird."

It is a pity that this wish has not been fulfilled, for when later on, in 1912, the museum had to be enlarged as there was lack of room, the private laboratory for foreign zoologists was again abolished. Yet in this period from 1901–1911 no less than 23 zoologists, taxonomists included, have made use of the Zoological laboratory. It is to be regretted that the existence of a separate zoological laboratory could not be maintained and that no attempts have ever been made to stimulate its more independent existence under a separate leader as has been the case with the Botanical station.

In the Pharmacological laboratory (later Phytochemical laboratory) foreigners have also repeatedly worked. The first to make investigations especially in this laboratory was Prof. P. C. PLUGGE, from Groningen, who died only a few weeks after his arrival at Buitenzorg in 1897.

The years that record the greatest number of visitors were 1898 and 1899, when a great many scientists stayed at Buitenzorg. It was once more an international party that worked here in 1898: Dr. NYMAN from Upsala, Prof. MOLISCH from Prague, some Germans, Dutch and Swiss, among which latter were Prof. C. SCHRÖTER from Zürich, Dr. RACIBORSKI from the Experimental Station at Tegal, Prof. BIRO from Budapest and two Russians. Among the Dutch there was also a medical colleague, Dr. A. W. NIEUWENHUIS, the well-known Borneo explorer, who at Buitenzorg made an investigation on a skin disease caused by a fungus. There were not only botanists but also chemists and zoologists, the investigations were plant-physiological, biological and chemical, whereas embryological, anatomical and taxonomic studies were made of plants and animals. It must have been a great satisfaction for TREUB, the founder of the station, to witness how his call had been answered and how various and divergent scientific problems were tackled by such an international congregation of learned men. So he could rightly testify in the Report of the Botanical Gardens over 1897 that this institute had become "an international scientific station whose fame was ever increasing in consequence of the continuous visits of foreign scholars."

While we have seen how in 1901 a centre was created for zoological investigations, it soon appeared that there was also need of a marine station, where visitors of the Botanical Gardens might find an opportunity for observations and studies in loco.

The marine station that (from 1884–1891) existed at Batavia in the building of the Royal Science Society, and that had offered this opportunity, albeit on a small scale, to several Dutch and foreign scholars, had ceased to exist since its founder and leader, Dr. C. PH. SLUITER, had left for Amsterdam, where he was appointed professor of zoology.

So there were made attempts in Holland to collect money for the erection of a small station at the seaside for the study of marine fauna. In 1904 *f* 2500. — had been brought together for this purpose. At the same time the necessity of a laboratory near the sea had been proved with a view to the interests of the fisheries. These two plans were then combined and in 1905 the Fisheries Laboratory arose in Batavia, which also offered accommodation for foreign zoologists.

After the departure of Dr. JANSE in 1899, who, when in Holland, was appointed professor of botany at Leyden, there ensued a period of some lack of continuity as to the leadership of the department of "Botanical laboratories." Dr. J. VAN BREDA DE HAAN was in the following year appointed to succeed Dr. JANSE. He had been chief of the Laboratory for the investigation of Deli Tobacco, and in 1905, when he was made chief of the Rice Experimental Station, he again passed on his task at the laboratory to Dr. CH. BERNARD. Again BERNARD had to resign office when, at the end of 1907, he was made chief of the Tea Experimental Station. His successor, Dr. H. P. KUYPER, was expected to be the right man for the task awaiting him. However, as early as January 1909 he died and was succeeded by Dr. P. J. S. CRAMER, botanist at the Coffee-culture laboratory. Towards the end of the same year Dr. CRAMER also left Netherlands India, to go to Suriname for a period of three years as Director of Agriculture.

Only after the leave of Dr. CRAMER, whose place was taken by Dr. C. J. J. VAN HALL, some stability came again in the leadership of the Botanical laboratories. At the same time, however, the real Botanical laboratory was segregated and its work was officially confined to the study of plant-diseases, which had practically been the case from the very beginning. For the care of the Foreigners' laboratory and the assistance given to the foreigners in their investigations was hardly to be combined with a thorough study of plant-diseases, for the purpose of which one has often to be absent from Buitenzorg for some length of time in order to make local studies.

So the Foreigners' laboratory and the laboratory at Tjibodas were now put together under one head, and in 1910 Dr. F. C. VON FABER, former botanist at the above mentioned laboratory for Coffee culture, was appointed to this position. At the same time this reformed de-

partment of "Botanical laboratories" was charged with the task of general anatomical, physiological and biological investigation of the tropical flora.

With Dr. VON FABER a new period of continuity in the leadership of the Foreigners' laboratory was initiated. And now that the head was no longer concerned with plant diseases, more time could be devoted to general botanical investigation, for which there was very good reason, since this research-work should not be left merely to occasional foreign visitors. Indeed, for the leading of the laboratory and enlightening of foreign investigators it is highly desirable that at the head of the Botanical laboratories there should be a man of some wider knowledge, who is familiar with the different biological problems that may occur in the tropics.

As mentioned above, former investigations at the Botanical laboratory had mostly been concerning plant-diseases. Only Dr. BERNARD, during the short period when he was at the head of the institute, had also occupied himself with purely botanical subjects. As such we may mention his studies about saprophytes, fresh-water algae, the physiology of latex-producing plants and some Javanese phalloids.

Only after the appointment of Dr. VON FABER, and when a separate department for plant pathology had been instituted, could the new task of the Botanical laboratories be fully attended to. VON FABER has indeed interested himself in various subjects and many problems have been tackled by him. We may more particularly mention here:- symbiosis of several tropical plants with bacteria that live in hereditary community with the higher plants; about iridescent bodies in the cells of red algae; an investigation concerning the movements of *Biophytum* and *Mimosa*; the physiology of the tropical forest; the physiology and biology of mangrove plants and crater plants, especially those of the solfatara's.

Although it seemed that with the appointment of a separate head non-taxonomic botanical investigation at the laboratory was to enter a period of prosperity, the Great War put a sudden stop to the co-operation of foreign investigators, for not only during the war but for a long time afterwards this was wanting. In May 1914, just before the outbreak of the war the new laboratory intended for investigators from elsewhere could yet be festively initiated. For the erection of this laboratory the "Committee for homage to Treub," which had been formed in 1911 in order to do honor to the memory of TREUB, had collected *f* 17,000. This laboratory was therefore named "Treub laboratory," in honour of the man who had not only been the moving power in facilitating the visits of botanists, but who had always untiringly continued his attempts to draw hither more and more students from all countries. The solemn inauguration of the building took place, in the presence of the Governor General, by the then Director of the Botanical Gardens, Dr. J. C. KONINGSBERGER, who in a speech entitled "Horrea replen'da" pointed out how this laboratory, meant for scientific research-work, was to serve in constantly adding to our knowledge of tropical plant-life.

The centenary of the Botanical Gardens occurred during the Great War, in May 1917. Circumstances did not allow then to celebrate this memorable fact except for the publication of a simple Memorial volume. Yet a committee was formed for the offering of a token of homage. This committee collected *f* 23,000.— for the purpose of building a modern laboratory in the mountain-garden at Tjibodas, as a worthy counterpart of the Treub laboratory at Buitenzorg. Only after the war, in August 1920, could this new laboratory be opened, and thus physiological work connected with the study of mountain flora could be pursued to better advantage.

When the new Laboratory for the Investigation of the Sea was built at Batavia, there was also arranged for a special room with three tables for the accommodation of foreign students. Dr. TH. MORTENSEN from Copenhagen was the first foreign guest of the new laboratory on his return from the Kei islands with the Danish expedition in 1922. He was engaged in the study of artificial fertilization of different echinoderms.

During Dr. VON FABER's absence on leave to Europe CH. COSTER of the Netherlands Indies Forest Service was put in charge of the Botanical laboratories of the Gardens. During this time, March 1925 to June 1926, he studied the following subjects:- periodical flowering, especially of *Dendrobium crumenatum*; annual rings and physiology of the secondary growth; diurnal fluctuations of the longitudinal growth of plants; and some minor investigations.

The post-war years were hardly propitious for lasting revival of scientific work, even in 1918 not a single foreigner pursued his studies in the Botanical Gardens. Only in 1927 and 1928 some new life sprang up — in 1928 there worked as many as 7 people in the Treub laboratory — and 1929, the year of the 4th Pacific Science Congress, held in Java, was even a "top year" in many respects, but then the relapse was the greater in the following five years. Economising measures cut deep. After Dr. VON FABER'S leaving in 1930 Dr. F. W. WENT, botanist attached to the Director of the Botanical Gardens' laboratory, took over the leadership of the laboratory, and when he went to America at the end of 1932 Dr. H. J. LAM, botanist at the Herbarium of Buitenzorg, was appointed. When after only six months the latter also left and went to Holland, to become Director of the National Herbarium at Leyden, further-reaching economy caused the position of chief of the Treub laboratory to be abolished.

Thus it is that the end of this short historical survey of the Foreigners' laboratory shows no cheerful features, but still we must not lose hope, but live on in the expectation that before long this laboratory may again have a leader of its own and that the great importance of this institute, even though its program is not a practical one, may be recognized. For a very great part of the fame that the Botanical Gardens enjoy all over the world is based on the fact that such a splendid opportunity exists here for foreign investigators to come and study. More than 250 visitors stayed here during the last fifty years for some length of time and all of them have had part in building up the name not only of the scientific institutes at Buitenzorg but also of Netherlands India.

It should therefore be remembered what TREUB has written, by way of introduction, in the guest book of the Foreigners' laboratory, *viz.* that the gardens at Buitenzorg offer several advantages to foreign botanists, but that this on the other hand enjoins an obligation to further

their investigations by all means possible. And has not D. G. FAIRCHILD on his visit in 1896 written in this same guest book the following words:- "I feel deeply indebted for the privilege granted me of spending eight months in the most complete and best equipped of Botanical Gardens in the world. I say this only after visiting over thirty-five of the best-known gardens in Europe and the East.

I look forward to the time when they shall become the great international centrum for biological investigation in the tropics . . ."

## LIST OF SCIENTISTS WHO WORKED IN THE FOREIGNERS' LABORATORY at Buitenzorg between 1884 and 1934, with some notes about their researches [5]

### 1883—1884

For the sake of completeness the first scientist who studied at the Botanical Gardens of Buitenzorg before the opening of the Foreigners' laboratory is also recorded:-

H. GRAF ZU SOLMS LAUBACH, professor of botany at Göttingen, who paid a visit to Java from October 1883 until March 1884. He made several provisional researches and collected a considerable amount of material for later studies. He made a.o. a study of the subterranean adventitious buds of *Psilotum triquetrum* and described some new fungi.

### 1885—1886

S. H. KOORDERS of the Netherlands Indian Forest Service visited the Botanical Gardens from January until March 1885 in order to get an insight of the Malay tree species. Moreover, he investigated the development of the germ and the structure of the seed of the teak tree (*Tectona grandis*) at different stadia.

Dr. A. KOROTNEFF from Moscow was the first zoologist who occupied a place in the laboratory for some time between May and August 1885. He studied mainly the nervous system of terrestrial Planaria, the fresh-water fauna and the anatomy of a peculiar species of whip-scorpion (*Thelyphonus* sp.).

Dr. N. DOUBROWINE from Moscow stayed for two months between May and September 1885. In the first place he wished to make a general survey of the Netherlands Indian flora by means of the Buitenzorg Garden before making an expedition through the Archipelago. In the second place he intended to bring together collections for the Botanical Museum of Moscow.

J. F. EIJKMAN, formerly professor of chemistry and pharmacology at the University of Tokyo, occupied himself during his stay from October 1885 until February 1886 with preliminary researches of plants which are of interest from a phytochemical point of view. The alcaloid content of a great number of plants was studied, whereas non-alcaloids or substances not yet specified were extracted from *Brucea, Samadera, Nauclea, Melia, Sarcocephalus, Crataeva, Mangifera* etc. An interesting colouring substance was found in *Orophea chrysocarpa* and *Cyathocalyx sumatrana*, a similar peculiar substance and a strongly fluorescent matter in *Cargalia maritima* and *Diospyros sapota*. The existence of fluorescent substances was also proved in the barks of most of the Aurantiaceae and Solanaceae, most prominent in those of *Aegle marmelos* and *Solandra grandiflora*. From the leaves of *Chavica Betle* an essential oil which has the same taste and odour as that of the leaves was separated. Furthermore the fat-content and the melting-point of some fat samples were ascertained, a.o. of *Palaquium javanicum*. Quantitative determinations of cocain were made from *Erythroxylon coca* cultivated in Java and other *Erythroxylon* species occurring in the Garden. Moreover, he made microscopic sections of plants of pharmacognostic importance, especially those which produce balsam, resin, tannin or essential oils.

Dr. K. VON GOEBEL, at that time professor of botany at the University of Rostock, stayed at Buitenzorg from November 1885 until March 1886 making morphological and biological researches with plants. The leaf formation and development of gemmae of epiphytic liverworts was studied, especially of some new forms of Tjibodas and environments. The development of the prothallium of the Hymenophyllaceae and other fern species was investigated and the formation of the sporophylls of *Helminthostachys* and the ferns generally; the heterophylly of *Polypodium*; the anatomy of Marattiaceae, *Nephrolepis* and other ferns. Further researches were made into the morphology of the flowers of tropical Cyperaceae and Gramineae; the development of the flower of *Limnocharis*; the development of the seed and embryo of *Crinum*; morphology of the Utriculariae and the development of the inflorescence of Javanese Urticaceae.

Dr. O. WARBURG from Hamburg studied from January until December 1886 especially the plant families in which lianas occur and made anatomical, biological and morphological investigations thereupon in connection with some physiological problems. More particularly anatomical work was done on the formation of the wood and the structure of the root. Investigations of a more biological kind concerned the different ways of adaptation of the climbing of the lianas, their dispersal, combination and presumable origin in the different families, their correlations and the phenomena of reduction; the distribution of the lianas generally and of special families particularly. Morphological problems studied were among others:- the sequence of short and long branches, the morphological significance of climbing organs, the formation of wings etc. Furthermore some physiological experiments were made upon the movement of sap, the irritability of twining branches and the swinging movement of tendrils. Also researches were made upon the structure of the wood of species related to lianas; upon the buttresses of stems and roots; aerial roots of stems and branches; the development of the buds of Caesalpiniaceae and Guttiferae; diseases of Cinchona and cauliflory.

Dr. H. MAYR, professor at the "Forstakademie" of München, stayed only a short time during 1886 at Buitenzorg. On his return voyage from America and Japan for the purpose of studying the forest vegetation of those countries, he used his short stay to make an herbarium collection of economic plants.

Dr. J. VAN EECKE, a surgeon of the Netherlands Indian army, occupied himself from October until December 1886 with bacteriological investigations of beri-beri and cultured two cocci found in tissues and body fluids of corpses as well as of living persons. Infection experiments with these cocci were made in the beri-beri hospital.

### 1888—1889

Dr. H. B. GUPPY, an English naturalist, visited the Botanical Gardens in 1888 and a number of seeds of shore plants collected by him on the Cocos-Keeling islands and floated for a considerable time on seawater were sown out in the Garden. Many of them germinated proving how long some species can stand this experiment.

Dr. J. G. BOERLAGE, curator of the Leyden Herbarium, was the first student who was sent out by the Dutch Buitenzorg fund. He left Holland together with TREUB, after the latter's leave, arriving at Buitenzorg in April 1888, for a stay of about four months. As before his arrival he had already begun a work dealing with the plant genera of Netherlands India he used the opportunity given by the Botanica Gardens to study these genera in loco and to trace the characters by which they are distinct. In the environment of Buitenzorg the wild species of plants were collected with the intention to publish lists of these plants. During his stay at Tjibodas chiefly the mountain flora was made a subject of study and a rich collection of rare plant forms was made.

Mrs. A. WEBER-VAN BOSSE for some weeks between the months of July and September 1888 made an investigation of parasitic algae which are found in the mountain garden at Tjibodas, chiefly *Mycoidea parasitica* occurring on leaves and of some aerial algae of the genus *Trentepohlia*. On a trip to Garoet Mrs. WEBER made a collection of algae, mainly those which are found in the hot springs at Telaga bodas.

Dr. MAX WEBER, professor of zoology at the municipal University of Amsterdam, also made use of the laboratory for about two months. During his stay he made a study

[5] Only the scientists engaged in laboratory researches are mentioned, those who made purely taxonomic studies at the Herbarium or Zoological Museum are omitted.

of the anatomy and the life-history of *Temnocephala*, an aberrant Trematod found on *Telphusa*, and the anatomy of fishes with accessory respiratory organs. Further representatives of different groups of animals were collected with a faunistic purpose and more especially the fresh-water fauna was studied.

Dr. A. TSCHIRCH, "Dozent" at the University of Berlin, occupied himself from November 1888 until February 1889 with studies on the anatomy and the development of the glands of many plant families; the occurrence of resin in plants with and without glands; the occurrence of secretions in fruits and seeds during the development and the germination. He investigated also the morphology and physiology of the germination of tropical seeds; development of the fruit and seed of *Strychnos* and some species of *Myristica*; the anatomy of some useful and medicinal plants.

Prof. E. SELENKA from Erlangen investigated in the laboratory the embryology of apes, shrews and some reptiles from April until July 1889.

### 1889—1890

Dr. G. KARSTEN from Rostock during his long stay from November 1888 until March 1890 studied the tropical vegetation in the Buitenzorg Garden. In the laboratory researches were made chiefly upon the development, morphology and biology of aerial algae of the genera *Chroolepus* and *Phycopeltis*, and the embryology and taxonomy of the genus *Gnetum*. Further studies were made of the distribution, development, morphology and biology of the rhizophores and the plants associated with them. Also experiments were made upon the purpose and significance of aerial roots and cultivations to study the appearance of these roots in seedlings. Moreover, the root formations, which do not serve nutritive purposes, were investigated. They occur in many monocotyledons (especially Pandanaceae and Palmae) and in some dicotyledons at the stem or root system.

Prof. Dr. W. SCHIMPER from Bonn made the following investigations during his stay in Java from October 1889 until March 1890:- Structure and life-history of beach vegetation; for these studies trips were made to Priok, Tjilintjing, the Island of Leiden and the "Duizend-eilanden," the rhizophore regions of Pasuruan and Probolinggo, the dunes of Wodjo at the south coast of Java, the coastal forests of Nusa Kembangan and the rhizophore regions along the "Kinderzee."

He studied the alpine flora of Java from a biological and plant-geographical standpoint, taking into account the corresponding vegetation of the solfataras and the lava fields of the Guntur. To study the alpine flora in loco the Pangerango and Gede, the Tjikorai, the Tengger and the Ardjuna mountains were climbed. Also the solfataras of the Salak, Telaga bodas and Kawah manuk and the craters of the Tangkuban Prahu, Guntur and Papandajan were visited.

Moreover, different aspects of tropical plant-life were studied; the development of buds and the mode of ramification.

Prof. Dr. E. STAHL from Jena, during the four and a half months (November 1889—March 1890) he spent in the Botanical Gardens at Buitenzorg, wanted primarily to get an insight into the flora of the tropics. More particularly the biology of the shade-plants (luminous plants, anisophylly) were investigated; the flowing off of the rain-water from the leaves; protective colours among plants and the biological significance of variation movements.

Dr. A. STRUBELL from Frankfort a/M. made use of the Botanical laboratory from April 1889 until February 1890. The purpose of his journey to Netherlands India was to get an insight into the animal world of the tropics, special attention being paid to the various conditions of life of the animals. For more extensive studies of a biological and geographical nature numerous data were collected on habitat, food, mode and time of propagation, care of the brood, influence of heat, draught etc., with reference to terrestrial as well as to fresh-water animals. Further material was obtained for the following researches:- embryology, anatomy and life-history of *Thelyphonus*; embryology of different Lacertilia; taxonomy, anatomy and life-history of terrestrial Planaria of West Java; structure and life-history of some helminthes; the mollusc fauna of the environments of Buitenzorg and embryology of *Manis javanica*.

Dr. C. LAUTERBACH from Breslau, on his way to German New Guinea to make a botanical exploration, spent some ten days in January 1890 in Buitenzorg for a provisional orientation. As he returned from New Guinea on account of ill-health he had to give up his original plan to occupy again a table in the laboratory for some months and was obliged to go back to Europe.

Dr. H. DRIESCH and Dr. C. HERBST from Jena made use of the laboratory for ten days only during January 1890 to get a provisional acquaintance with some faunistic problems.

Dr. F. A. F. C. WENT from the Hague worked in the Botanical laboratory at Buitenzorg from March until July 1890, being rovided with a grant from the Dutch Buitenzorg fund. Various botanical trips were made with the aim to get a proper idea of the peculiarities of the tropical vegetation and to get acquainted with different tropical cultures. More particularly the following problems were investigated in the laboratory or materials collected for future researches in Holland:- the physiology and biology of the adhesive roots of epiphytes and climbing plants; the shedding of branches by *Castilloa elastica* and some other trees and the closing of the wounds made thereby; the extrafloral nectaria and their development in the species of the genus *Fagraea*; the aecidium galls of *Albizzia montana*.

A. BREWER from Halle a/S. occupied himself during some five weeks in the months of August and September 1890 with a provisional study of the structure and the diseases of the sugar-cane.

Dr. J. F. VAN BEMMELEN from Amsterdam intended to study, during the months of July and August 1890, the embryology of tortoises, either of a fresh-water or of a terrestrial species. For want of material this investigation yielded no results but at the south coast of Java a complete series of embryological stadia of *Chelonia viridis* was obtained. Also embryos of different snakes and lizards were collected. Furthermore, the development of the wings of *Papilio agamemnon* and *Bombyx trifenestrata* was investigated.

S. H. KOORDERS of the Netherlands Indian Forest Service concluded his researches begun in 1885 on the embryology of the teak tree (*Tectona grandis*), during the months of November and December 1890.

J. Z. KANNEGIETER from Amsterdam made use of the laboratory in January and February 1890 and later on from October 1890 until April 1891 to arrange his zoological collections made in Sumatra and Java.

### 1891—1892

Prof. Dr. W. TICHOMIROW, Russian Councillor of State and professor at the University of Moscow, stayed at Buitenzorg for several weeks in 1891. He was charged by his government to report on the tropical botanical institutions visited by him and in consequence of his report the Russian Government gave evidence of its appreciation of the Buitenzorg Botanical Gardens.

Dr. TH. VALETON, bacteriologist of the Experiment Station for sugar-cane at Pasuruan, visited Buitenzorg in March 1891 for some weeks with the purpose of following the bacteriological researches of the sugar-cane made by Dr. JANSE, then Chief of the Botanical laboratories.

Dr. CARL W. S. AURIVILLIUS from Upsala stayed at Buitenzorg during the months of May and August 1891 to collect fresh-water animals (especially crustaceans and molluscs) as well as insects.

ARTHUR WARD from Oxford occupied himself from November 1891 until January 1892 mainly with a study of the morphology and anatomy of representatives of various typical tropical plant families.

Prof. G. HABERLANDT, professor of botany at the University of Graz, studied during his stay at Buitenzorg from November 1891 until February 1892 chiefly the following problems:- anatomical and physiological researches of tropical leaves; in addition to a series of experiments about evaporation, the structure and function of the water absorbing and secreting organs of the leaves in different plant families was investigated. Further he made experiments on the adaptive phenomena of epiphytic plants; observations about the anatomy and development of some mangrove plants; the stimulative movement and transmission of the stimulation in *Oxalis sensitiva*.

Dr. J. C. COSTERUS from Amsterdam, having the opportunity to visit the Botanical station by a grant from the

Buitenzorg fund, investigated during his stay from February until June 1892 the structure of the flowers of *Grammatophyllum speciosum*, the lowest part of the inflorescence of which shows always the same divergence. He also made studies on the mode of germination of the seeds of different tropical plants, and the quantity of organic matter which accumulates during the daytime in the leaves and disappears during the night; the times of the day in which the maximum of assimilation products is attained in different plants and the influence of cloudiness on this process.

Prof. F. KAMIENSKI from Odessa worked in the Botanical station for more than one month (May—June 1892), studying mainly the morphology of *Utricularia* species.

Prof. A. KRASNOW from Charkow returning to Russia from a journey to Sachalin and Japan, where he had made plant-geographical studies, stayed at Buitenzorg about four weeks in October and November 1892 to investigate the tropical flora and the genera which the tropics and the temperate zones have in common.

Thanks to the photographic room attached to the laboratory he returned to his country with a collection of photographs of the most characteristic forms of tropical nature and of the natural plant groups, descriptions of which only give a very feeble image.

### 1892—1893

Dr. R. SEMON, professor at Jena, arrived at Buitenzorg in the month of November 1892 on his home-voyage from Australia, New Guinea etc. and set about the collecting of animals for anatomical and embryological researches (*Manis*, *Tupaja* and Lacertilia).

In March 1893 Prof. SEMON was again in Buitenzorg for a short time upon his return from Ambon before going back to Germany. In Buitenzorg and Tjibodas he made chiefly faunistic and embryological studies. In connection with his voyage and stay in the Moluccas he recommended some localities for further marine zoological investigations, such as Ternate, Batjan and Lontor, especially during the East monsoon (May—October).

Dr. P. ANEMA from Batavia, during the month of June 1893, started microchemical investigations of the localisation of the alcaloids in the *Strychnos*-species represented in the garden. He planned to continue these researches later especially with reference to the appearance of the alcaloid during growth.

Prof. W. KÜKENTHAL from Jena on his way to Ternate stayed at the Botanical station a few weeks in November and December 1893 and spent his time mainly in collecting different animal species.

### 1893—1894

Prof. Dr. L. VON GRAFF from Graz made a study of the terrestrial Planaria from November 1893 until January 1894 in connection with a monograph of this group already nearly completed. He brought together also an extremely rich collection of the said animals whereas further a collection was made of the most diverse and important zoological objects for the use of the Zoological-zootomical Institute at Graz.

Prof. Dr. J. WIESNER, professor and director of the Botanical-physiological Laboratory at Vienna, occupied himself during his stay at Buitenzorg from November 1893 until February 1894 in the first place with a study on the relation between the intensity of the light and the form and development of the plants in the tropics in connection with his former photometric researches. As a base, determinations of the intensity of the daylight at different hours of the day were used after the method of Bunsen-Roscoe. These determinations were made together with Dr. FIGDOR. Moreover he studied:- the position taken by leaves in connection with the incident light-rays; the protection of the chlorophyll; the chiefly ombrophilous character of the plants growing in Buitenzorg; the germination of the *Viscum*- and *Loranthus*-species in comparison with the European *Viscum album*; the mechanical action of tropical rains on the plant growth; the anisophylly; the unequal growth of the wood of different trees and of the bark of Annonaceae and Tiliaceae; and finally the growth movements of some flower parts.

Dr. W. FIGDOR from Vienna stayed at Buitenzorg from November 1893 until February 1894 and investigated more particularly the movement of the air and the water in the wood of various trees using closed mercurial manometres; the development of the germ of some orchids; the biological phenomena of *Cotylanthera*, and collected material for a future anatomical and taxonomic study of this plant.

Prof. Dr. GR. KRAUS from Halle remained at Buitenzorg from November 1893 until February 1894. The aim of his stay in the first place was to get a proper idea of the tropical plant world. More particularly the following subjects were studied:- the "grand period" of growth of the sprouts of a bamboo species (*Dendrocalamus giganteus*); the secondary growth of the stem of different palms, material being also collected for anatomical researches of those stems; the heat liberated in the flowers of Cycadaceae and Palmae; the diurnal swelling of the wood of various trees; the height of numerous trees in the Botanical Garden.

Dr. V. SCHIFFNER from Prague stayed at the Botanical station from November 1893 until July 1894 and made an extensive collection of the mosses and liverworts occurring at Buitenzorg and Tjibodas.

Dr. TH. ADENSAMER from Vienna remained at Buitenzorg from December 1893 until March 1894 to bring together material for zoological studies, a.o. Cestodes from *Python* and *Varanus* were collected.

The priest J. J. HOEVENAARS from Surabaya worked in the laboratory from October until November 1894 identifying plants in order to obtain a survey of the tropical flora.

Dr. A. WILLEY from Oxford on his way to the South-sea islands stayed for a short time in the laboratory (November 1894) and collected various zoological materials. At Tjibodas he discovered the young of *Perichaeta* in the humus of epiphytic ferns.

### 1894—1895

Prof. V. A. POULSEN, professor from Copenhagen, remained at Buitenzorg from December 1894 until February 1895, enabled by the Carlsberg fund. The aim of his visit was chiefly to get material of saprophytes without chlorophyll and to study these plants in connection with his former publications on this subject. Various less extensive anatomical researches were also commenced, more especially those on the extrafloral nectaria and of some interesting lichens. Moreover, the opportunity was used to get acquainted with the plants and their products which are important from a pharmacological standpoint.

Dr. J. MASSART from Brussels occupied himself during the seven months which he stayed in Java, from August 1894 until February 1895, chiefly with a study of the tropical flora. He investigated from a physiological point of view the conditions of the pollination of *Dendrobium crumenatum*, the germination of *Cocos nucifera* and the differentiation shown by the branches of several lianas. Further on he made observations at Tjibodas on plagiotropic branches, on pinnate leaves, epiphyllous plants and Hymenolichens.

Dr. M. MIYOSHI from Tokyo devoted his short stay, from February until March 1895, at the Botanical Garden mainly to the study of the characteristic habitus of tropical plants, especially of Palmae, Pandanaceae and orchids, as a preparation for a future more prolonged visit.

### 1895—1896

Dr. E. GILTAY, teacher at the Agricultural School at Wageningen, to whom the biennial subvention of the Dutch Buitenzorg fund had been granted, stayed at Buitenzorg from September 1895 until January 1896. In the first place he occupied himself with an investigation about the intensity of the assimilation in the tropics in comparison with that of plants in Europe. He worked with a plant which is also much used in Europe for this purpose, *i.e.* the sunflower, *Helianthus annuus*. A second investigation referred to the evaporation of plants in the Buitenzorg climate, for this study also the said plant being again used, in order to compare tropical conditions with conditions in N. Europe.

Dr. C. HOLTERMANN from Christiania occupied himself during his stay of some eleven months from July 1895 until May 1896 with the study and the culture of different fungi.

J. Z. KANNEGIETER, curator of the Berkenstein museum at Rijsenburg near Utrecht, who also formerly in the years 1890 and 1891 visited Buitenzorg, made use of a place in the Foreigners' laboratory during some two months in 1896, between his voyages to Nias and Pulu Tello.

Dr. A. G. VORDERMAN, inspector of the Civil Health Service, stayed twice, in April and November 1896, each

time for about a week, in the laboratory with the purpose of making microscopical and microchemical researches about rice and corn species.

Dr. D. G. FAIRCHILD of the Department of Agriculture at Washington stayed at the Botanical station from April until December 1896 and studied the following subjects:- the relation between the fungi of termites' nests and the food of these insects; the behaviour of the nuclei at the development of *Phylophysa Treubii*; morphology of some Collemaceae; morphology and mitosis in different Gymnoasci; morphology of a new species of *Entyloma* causing a kind of witches' broom on *Selaginella* found at Tjibodas; mitosis in a new species of *Exobasidium* living on the leaves of *Calpandria lanceolata*.

### 1896—1897

Prof. O. PENZIG, professor of botany at the University of Genoa, devoted himself from November 1896 until March 1897 to the following problems:- the micromycetes and preferably the Myxomycetes of the environments of Buitenzorg and Tjibodas. The last-named are worked out separately as a contribution to the "Flora of Buitenzorg." Of some very peculiar species material was collected for the study of their development. Further investigations were made on acarodomatia; morphology and anatomy of *Voandzeia subterranea*; subsidiary work on the protection of the flower-buds of *Clerodendron* and other Verbenaceae, and on the germination of some Euphorbiaceae.

Dr. G. CLAUTRIAU of the Botanical Institute at Brussels stayed at Buitenzorg from September 1896 until March 1897 and occupied himself mainly with a study of the localization of the alcaloids in different plants (coffee, tea a.o.) and of their physiological significance.

Dr. A. J. EWART from Liverpool during his stay from November 1896 until the end of March 1897 chiefly made investigations about the assimilation and the significance and action of chlorophyll by means of the bacteria method of Prof. ENGELMANN, and the physiology of the hooks of various climbing plants such as *Uncaria* and others.

Dr. HJ. MÖLLER from Lund, who remained seven months and a half until September 1897, used his time mainly for collecting various materials on behalf of the Natural History Museum at Lund. Moreover, Dr. MÖLLER paid special attention to the beach flora of Palabuan ratu and to the tissues of mosses which function as water receptacles.

Prof. P. C. PLUGGE from Groningen, sent out by the "Buitenzorg fund," arrived at Buitenzorg in May 1897 for the purpose of collecting for some four months a great many phytochemical and pharmacological data and materials. He worked mainly in the Pharmacological laboratory but died a few weeks after his arrival.

### 1897—1898

Prof. H. MOLISCH from Prague made during his stay from November 1897 until January 1898 researches into the preparation of indigo viewed from plant-physiological standpoint; the flowing of water from cut-off stems of lianas; the "bleeding" of trees well provided with leaves; the obtaining of sugary sap from various palms; the cause of the occurrence of "tabaschir" in bamboo; the peculiar symbiosis of the leaves of Convolvulaceae and a fungus; and luminous fungi.

Macro- and microchemical investigations about a new plant containing cumarine (*Ageratum conyzoides*) were carried on: about a new plant containing indigo (*Echites religiosa*); about orlean, a colouring substance of *Bixa Orellana*; about a chromogen in the cells of Acanthaceae and Urticaceae containing cystoliths; about the secretion of mucilage in ferns, *Lycopodium spectabile* and Commelinaceae.

Dr. A. W. NIEUWENHUIS was temporarily connected with the laboratory from November 1897 until May 1898 to make researches into the plant organisms which cause the cutaneous disease known as "*Tinea imbricata*" and named "*lusong*" in Central Borneo. The organism causing the disease, a parasitic fungus living in the human skin, was studied by microscope and could be cultured on an artificial medium in the laboratory. The fungus raised in the laboratory proved to be able to produce on the human skin the symptoms of "*Tinea imbricata*."

Dr. M. RACIBORSKI of the Experiment Station at Kagok in Tegal studied in March 1898 the occurrence of leptomine in a great number of various plants. He investigated further the "protocorms" of *Taeniophyllum* and *Aeranthus* and the so-called "food-bodies" of some species of *Leea*.

Prof. Dr. L. BIRO from Budapest made use of his short stay in 1898 to collect and to study provisionally various interesting forms of animal life.

### 1898—1899

Dr. ERIK NYMAN from Upsala during his long stay, from the end of 1897 until the beginning of 1899, in the first place brought together an extensive collection of biological objects for the botanical lectures at the University of Upsala. Further on he made observations on some biological subjects namely on nectaria, floral as well as extrafloral ones, also on flower biology. Also Dr. NYMAN occupied himself with a study of lower cryptogams, especially fungi.

MAX FLEISCHER from Berlin arrived in 1898 and worked at the Botanical station. During his several years' sojourn in Java he studied chiefly mosses and worked out *e.g.* the Musci for the "Flora of Buitenzorg."

PROF. M. WESTERMAIER, professor of botany at Freiburg (Switzerland), remained from October 1898 until February 1899. He devoted himself to embryological studies, particularly of antipods; the physiological and anatomical relations of the junction of branches and stalks and pending organs; the anatomy of *Eriodendron anfractuosum* and some mosses; the mode of secondary growth in vascular cryptogams and the mechanism of the shedding of leaves in many plants. For future study of these and other problems and for demonstration at lectures materials were collected.

Prof. P. KNUTH from Kiel, who died shortly after his visit to Buitenzorg, from November 1898 until March 1899, studied at Buitenzorg the inflorescences of about 200 plant species and ascertained their pollinators. Particularly the following problems were worked out:- the inflorescences of palms; the relation between flowers and birds in the Malay Archipelago; archocleistogamous flowers; stem and ground flowers; biological and statistical researches into the pollination of flowers by insects in Java; biological studies about the inflorescences of species of the genera *Cassia* and *Mussaenda*; pollination by bats and snails.

Prof. C. SCHRÖTER and M. PERNOD from Zürich used their short stay in January 1899 not only for a general survey of the tropical flora but also to bring together important collections at Buitenzorg and Tjibodas.

Prof. S. NAWASCHIN from Kiew, sent out by the Imperial Academy of Sciences at St. Petersburg, during his stay of four months till April 1899 in the first place occupied himself with critical collection of materials for future more detailed researches on floral development. For this purpose different families of monocotyledons were selected, *e.g.* complete material for such a study of various palms was brought together. In connection with his well-known study on the fertilization in the Liliaceae Prof. NAWASCHIN devoted special attention to many representatives of this family, particularly the arboreous *Dracaena's* and *Cordyline's* and the two species of *Gloriosa* cultivated in the Botanical Garden.

W. KARAWAIEW, assistant at the Zoological laboratory of the University at Kiew, occupied himself from December 1898 until April 1899 with zoological subjects. He prepared and fixed embryos of various common lizards and some snakes. A rich material of lizards proved to be obtainable in the most diverse stadia of development. Of *Manis* only two rather old embryos of the same stadium could be collected. Further he collected material of *Thelyphonus* and scorpions injected according to the method of Prof. KOWALEWSKY and fixed, moreover, different objects for histological purposes.

Dr. S. KAESTNER from Leipzig came in 1899 to collect embryological material of animals. His original intention was to stay only a few weeks but as Buitenzorg proved to be a very rich locality also for zoological purposes he prolonged his sojourn to about two months.

To Prof. MAX WEBER, the leader of the Siboga expedition, and to Mrs. WEBER hospitality in the Buitenzorg laboratories was afforded in the beginning of 1899 for a few weeks. More particularly the photographic room was of some use for the preparation of the photographic work during the expedition.

### 1899—1900

Dr. K. GIESENHAGEN from München during his stay at Buitenzorg from October 1899 until February 1900 devoted his time chiefly to some problems regarding the organography and anatomy, growth and life-history of epiphytic ferns. During his visit to Sumatra these investigations were amplified by observations about the influence of the monsoon and trade-winds on the habit and dispersal of epiphytic ferns, more particularly of species of *Nipholobus*. At Tjibodas and during his voyages in Sumatra the moss flora of the primeval forest was studied and a rich material of great interest for the knowledge of the biology of the said mosses was collected.

Dr. E. MEAD WILCOX of Harvard University at Cambridge, Mass. (U.S.A.) occupied himself from October 1899 until March 1900 chiefly with researches concerning the most important crops of the tropics, more especially with sugar-cane.

LEON PYNAERT from Antwerp remained a long time at Buitenzorg from September 1899 until April 1900 and acquainted himself with the tropical cultures in view of the establishment of a botanical garden for practical and scientific purposes in the Congo, with the organization of which he was charged.

Dr. A. H. SCHMIDT from Utrecht, to whom the subvention of the Buitenzorg fund for 1898 was granted, remained during two months, from December 1898 until February 1899; after the ending of the Siboga expedition he came in March 1900 again to Buitenzorg for a two months' stay. He investigated luminous bacteria occurring on the skin of seafishes. He succeeded in growing *Photobacterium javanensis* on artificial media, which in no way lessened the luminescence. During his second sojourn at Buitenzorg he studied chiefly the microbes occurring constantly in the liquid content of the young flower-buds of *Spathodea campanulata*. It proved that as a rule always the same species of bacterium, which was also found in the atmosphere, is present in these buds.

Dr. A. PREYER from Berlin stayed about ten months till November 1900 at Buitenzorg. His chief aim was to get acquainted with the tropical crops and their cultivation. Further he made researches concerning the fermentation of cacao; the anatomy and the economic value of the bark fibres of Boehmeriaceae; the preparation of ramie fibres; rational methods of tapping rubber latex; fermentation of coffee; economic value of some kinds of resin; preparation of cananga oil; some kinds of yeast occurring in fermenting fruits.

### 1900—1901

Prof. E. HAECKEL from Jena stayed from October 1900 until January 1901. One of the chief aims of his sojourn was the study of the fresh-water plankton of Java. Further on he occupied himself with the making of illustrations of interesting forms for his work "Kunstformen der Natur." He also used the opportunity to make observations concerning the embryology of the vertebrates and articulata and to collect material for the Zoological Institute at Jena.

Dr. E. PALLA from Graz devoted his stay of three months at Buitenzorg (till February 1901) mainly to a study and the taxonomy of some cryptogamic families.

Dr. A. W. NIEUWENHUIS remained at Buitenzorg during five months from January until May 1901 after his last voyage to Borneo. He used this opportunity to study in the laboratory another skin disease which produces parasitic growths in the sole and the palm of the hand. Its cause proved to be also a fungus (*Tinea albigena*).

The abbot U. LEGRÉ from Marseille stayed seven months till July 1901 and in the first place paid his attention to the morphology of the lianas and of various spined organs. The spathe of the Aroids provided another subject of study, from which a rich material could be prepared and taken home for future investigation.

The baroness Dr. M. VON UEXKÜLL stayed at Buitenzorg from January until August 1901. The chief theme of her researches was the study of the extra-floral organs which secrete sugar in connection with the animals which visit these flowers, especially ants. Contrary to other observations no protection of the flowers by the ants against damage by bumblebees, wasps etc. could be determined.

The mode of dispersal of the fruits of *Thuarea sarmentosa* was motive for an anatomical and biological investigation; further the cauliflory and the nyctitropic movements of flowers which are favourable for autogamy were studied.

Dr. S. L. SCHOUTEN from Utrecht remained at Buitenzorg from July until November 1901 which visit was enabled by a grant from the Buitenzorg fund. Besides a more general study of tropical nature he paid special attention to the culture of algae, the biology of parasitic fungi, to which study a fungous disease of *Corchorus capsularis* offered an opportunity; and finally to the origin of mutations in lower organisms, particularly *Rhizopus oryzae*.

The Russian zoologist Dr. D. PEDASCHENKO was the first scientist who could continue his researches in the new Zoological laboratory established in 1901. He returned to Europe with a rich scientific material.

C. L. MARLATT, one of the entomological specialists of the U.S. Department of Agriculture at Washington, also worked in the new Zoological laboratory during a few weeks in 1901. The material collected during his voyage in Java and sent regularly to Buitenzorg was prepared in the proper way for future investigation and could be taken along to the States without danger of losing its value.

### 1901—1902

Dr. O. SPIRE who stayed in Java till March 1902 made a study in charge of the French Ministry of the Colonies of rubber-producing plants and occupied himself further on mainly with investigations concerning the anatomy of the Apocynaceae.

Dr. F. DIERCKX from Louvain paid a visit of eight months (till April 1902) to Java enabled by a subvention granted by the Belgian Government. In connection with his monograph on *Penicillium*, *Aspergillus*, etc. further material for these investigations was collected. A study of the development of the pollen, the ovulum and the embryo was made and a collection brought together of objects of didactic value which could serve for demonstration at lectures.

Dr. F. H. LANG from München during his stay from September 1901 until February 1902 devoted himself chiefly to anatomical researches of epiphytic orchids.

Dr. G. VOLKENS from Berlin used his sojourn of more than six months (till July 1902) for the investigation of the phenomena occurring at the shedding of the leaves and the formation of new ones of tropical trees. He studied also at regular intervals the formation of the annual rings and some chemical physiological changes connected with the periods of rest and growth. The different modes of branching and also the formation of short- and long-living leaves formed a subject of his investigations. Also a collection of economic plants and of demonstration materials was brought together for the Berlin Botanical Museum.

Dr. C. DAWYDOFF worked in the Zoological laboratory making a scientific voyage to Netherlands India in charge of the Academy of Sciences at St. Petersburg. This naturalist stayed at Buitenzorg from May until July 1902 and occupied himself mainly with the embryology of *Thelyphonus* and the preservation of material to be worked out later on in Europe. He investigated also certain organs of numerous insects and Pedipalpi the structure and the function of which is still insufficiently known. At the end of July he set out on a voyage to the eastern part of the Archipelago returning to Buitenzorg the first of October and after a stay of only a few days he travelled back to Europe.

### 1902—1903

Prof. M. BÜSGEN from Münden (Hannover) stayed during more than five months from October 1902 until February 1903. In the first place he devoted his attention to the various types of root system of a great many woody plants, the Botanical gardens at Buitenzorg and Tjibodas and the Economic garden offering a rich material. In the lastnamed garden the influence of lime on a number of economic plants was investigated and the peculiar secretion of silicic acid by a species of *Costus* was also studied.

In compliance with a charge of the Ministry of the Colonies in Germany a special study was made of the organization of the Forest Service and the culture of teak wood, a visit being paid to Central Java for this purpose.

Dr. W. BUSSE from Berlin remained also from October 1902 until February 1903 which stay was interrupted twice by a trip to the Preanger and East Java. At Buitenzorg

the chemical and physiological processes occurring when drying cloves were studied. Further he made researches into *Andropogon Sorghum* and more particularly about the plant and animal parasites of this crop. As far as time was left some observations were made on lichens and algae occurring on leaves. The aim of the visit to the Preanger and East Java was to get acquainted with the culture of cinchona, tea, coffee and sugar-cane.

Dr. J. C. SCHOUTE from Groningen, who stayed at Buitenzorg from February until June 1903, occupied himself chiefly with a study of the secondary growth of palms making a corresponding research of the tree ferns. Further the formation of the stem of Pandanaceae was investigated and finally some material was collected for future research of non or feebly geotropic roots in view of the statolith-theory of HABERLANDT and NEMEČ.

Prof. D. BOIS from Paris devoted himself at Buitenzorg during more than one month from February until March 1903 mainly to taxonomic studies and the collection of an extensive herbarium.

Dr. CH. S. SARGENT, Director of the Arnold Arboretum at Jamaica Plain, Mass., in the beginning of 1903 remained some weeks spending some time at Tjibodas too. He studied various forms of trees especially conifers.

Dr. N. E. SVEDELIUS from Upsala stayed in 1903 also a short time in the laboratory and spent his time mainly on an investigation of the flowers and germination of *Strychnos*.

Dr. TH. WEEVERS from Amsterdam and Mrs. C. J. WEEVERS-DEGRAAFF worked in Buitenzorg from December 1902 until April 1903 investigating the significance of cafeïn and theobromin in the metabolic processes of the plant; this research was made in the Experimental gardens. At Tjibodas an investigation into the formation of anthocyan was carried out.

### 1903—1904

Prof. E. HEINRICHER from Innsbruck paid a visit from November 1903 until January 1904. His aim was to study the parasitic phanerogams of the tropics especially the Rafflesiaceae and Balanophoreae. A new species of *Brugmansia* offered material for further histological researches. His investigations included also the study of nectaria in *Diospyros discolor*, the hydrenchyma and the fruit of *Hydrolea spinosa* and the peculiar hydrenchyma of *Rhododendrum javanicum*.

Dr. H. WINKLER from Tübingen stayed at Buitenzorg from November 1903 until May 1904. The chief purpose of his stay were ecological and plant-geographical researches. Besides during his stay at Buitenzorg on several trips to the vulcanoes of Java material was collected. In the Foreigners' laboratory the regenerative power of different plants was investigated by him, *e.g.* of *Phanera*. The fertilization of *Wikstroemia indica* and other Thymelaeaceae was another object of study, the result being that parthenogenesis probably occurs here. The dimorphism of the flowers of *Arachnanthe Lowei* was investigated, and the anisophylly and the expansion of the internodes of *Callicarpa hexandra*; the formation of tyloses in *Ipomoea violacea*, etc.

In charge of the German Government this visitor studied the culture of coca and cinchona for which purpose a visit was paid to various estates in Central and East Java.

Dr. F. RAMALEY of the University of Colorado at Boulder (U.S.A.) remained from February until April 1904. The chief aim of his visit was to bring together a collection of different tropical plants interesting from a morphological and biological point of view. A great many photographs were taken in the Botanical Garden and at Tjibodas to serve as demonstration material.

A. JOHN from Cairo also used his short sojourn in August 1904 for collecting and becoming acquainted with the tropical flora by making trips in the environment.

Prof. K. KRAEPELIN, Director of the Natural History Museum at Hamburg, worked from February until April 1904 in the laboratory for foreign zoologists and made various collections; he paid particular attention to the detritus forms.

### 1904—1905

Prof. W. DETMER, professor at Jena, during his stay from October 1904 till January 1905 made a special study of the presence of amylum in the leaves of tropical plants and investigated some of the external conditions influencing it. Further he studied the evaporation of plant parts exposed directly to the sun-rays. A trip to Central and East Java was made to get an insight into tea, cacao and cinchona culture and to collect soil samples.

Prof. M. GOLENKIN, Director of the Botanical Garden at Moscow, remained at Buitenzorg from December 1904 until May 1905. He brought together a collection of demonstration material for his lectures and made the necessary provisional studies about the development of some plants belonging partly to the mosses and ferns, partly to the phanerogams, special attention being paid to the parthenogenesis of angiosperms. The remarkable fact was discovered by him that the pollen tubes of *Agathis* penetrate into the young prothallus feeding on it in the way of fungous filaments. On his trips in the environment of Buitenzorg he discovered the two remarkable mosses *Treubia insignis* and *Ephemeropsis tjibodensis* on the Salak on the west as well as on the north side, hitherto found only on the Gede mountain.

### 1905—1906

Prof. A. ENGLER, Director of the Berlin Botanical Garden stayed at Buitenzorg from December 1905 until February 1906. He studied the different indigenous Araceae of Java and found in the Herbarium among the material not yet identified a great number of new species belonging to this family, especially from Borneo, and among the genera *Rhaphidophora*, *Schismatoglossis* and *Homalomena*. Observations made by him in Europe on the development of the roots, leaves and buds were continued with regard to the species represented here.

Finally during his excursions in Java he had an opportunity to study the tropical flora and to make interesting comparisons with similar regions of Africa.

Prof. D. H. CAMPBELL from Stanford University, California, collected from March until June 1906 a great quantity of material for a study of the development of the Ophioglosseae, particularly the germination stadia and prothallia. At Tjibodas he brought together a rich collection of liverworts and their different stages. Finally he obtained at Buitenzorg material for a study of the embryo-sac of many angiosperms, *e.g.* of Piperaceae, Cyclanthaceae, Araceae and Pandanaceae.

Prof. A. ERNST from Zürich remained in Netherlands India ten months, till June 1906, and was able to complete the most important parts of the program drawn up by him. During his stay at Tjibodas and his excursions to Krakatau, East and Central Java, Celebes and Lombok and finally during his stay at Padang he was able to get a proper idea of the tropical flora, the interesting habit of the mangrove, the virgin forest, and the alpine flora being especially studied. Moreover, he brought together a rich collection of demonstration material and a great many photographs chiefly concerning ecology.

Further he devoted his time partly to different physiological problems and paid attention to spermatogenesis and sporogenesis of the liverworts, the embryology of different Asclepiadeae, Apocyneae, *Rafflesia Patma*, *R. Hasseltii* etc. He also collected material for a study of saprophytes, of the plasmodesmata of *Phytophysa Treubii*, the development of Hymenolichenes etc.

A. A. PULLE enabled by a grant from the Buitenzorg fund studied the tropical flora from a taxonomic and ecological point of view from March to July 1906. He was able to make interesting comparisons between the flora of Java and Surinam. Moreover, he collected material for investigating the embryology of some palms and of *Pistia Stratiotes* and the presumable apogamy of various species of *Elatostemma*, *Tremo*, *Villebrunea* and *Diospyros*.

Dr. L. P. DE BUSSY, zoologist at the Experiment Station for tobacco at Medan, worked in the Zoological laboratory from July until the end of December 1906. He occupied himself with zoological problems of a general nature concerning his own sphere of activity as well as with collecting material for a study of the embryology of different reptiles,

Dr. P. IWANOFF, delegate of the Imperial Academy of Sciences at Petersburg, stayed on Java from August until December 1906 and worked in the Zoological laboratory as well as in the Fisheries laboratory at Batavia. At Buitenzorg he collected mainly embryological material of myriapods, spiders and other articulata and had a prominent suc-

cess with reference to the Scolopendrellidae, a small group little known in this respect. At Batavia he occupied himself with the collection of plankton and continued the study commenced in Buitenzorg about the development of *Limulus*.

## 1906—1907

Dr. M. KOERNICKE from Bonn arrived at Buitenzorg in October 1906 and departed in March 1907. He devoted his time to various problems of the biology of parasitic phanerogams, chiefly the life-history, the anatomy and histology of the Loranthaceae; to the comparative embryology of the sexual cells of the Balanophoraceae, etc. Further he studied the biological development of algae, fungi and bacteria living in the tissues of higher plants, the germination of different orchids and finally the rattan culture.

H. MORIN from München, the aim of whose voyage was chiefly to make illustrations for the new edition of "Brehm's Tierleben," spent his time, April to July 1907, partly in the Botanical, partly in the Zoological laboratory. During his stay he acquainted himself with the tropical flora and fauna and the principal crops of Java. He made a great many sketches and photographs in relation to the above-mentioned work and to other publications.

Miss A. L. VON GRAEVENITZ and Miss E. STEIN remained in Java in 1907 for a few months to study the tropical flora and to collect material.

Dr. PH. VAN HARREVELD from Groningen stayed at Buitenzorg from May until September 1907. He obtained interesting results of his researches upon guttation. He collected furthermore material for a study of the aerenchyma of *Neptunia oleracea* and *Jussiaea repens* and endeavoured to decide whether *Cassytha filiformis* is a true parasite or not.

Prof. M. MIYOSHI from Tokyo, who paid a visit to Buitenzorg twelve years earlier, remained on his return-voyage from Europe in 1907 from September until October. He made some investigations upon the structure of the leaves of tropical plants and studied the economic plants.

Prof. TH. BARBOUR of Harvard University (U.S.A.) during his stay in the Zoological laboratory at Buitenzorg in 1907 and a voyage through the Moluccas brought together important collections for the Harvard Museum.

FR. MUIR, entomologist of the Experiment Station of the Hawaiian Sugar Planters' Association at Honolulu, remained also in 1907 some time in the above-mentioned laboratory. His chief aim was to detect parasites of different insects which are very noxious in Hawaii.

## 1907—1908

Prof. F. CZAPEK from Czernowitz (Austria-Hungary), during his stay from November 1907 until February 1908, made observations and experiments upon climbing plants; on the pulvini of the leaf joints of Menispermaceae, tendrils of *Entada*, to produce by experiment free windings and anisophylly in winding Asclepiadeae and related species. Further he occupied himself with tropisms of the aerial roots of epiphytic orchids and the supply of water by these organs; dorsiventrality of *Elatostemma*; observations upon sleeping movements; the sensibility of pinnate leaves when irritated by shocks, and the structure and the tissue tension of the false stem of the Zingiberaceae.

Prof. F. VON HÖHNEL from Vienna visited Java from November 1907 until March 1908. The chief purpose of his voyage was to get an insight into the tropical fungous vegetation and to bring together by extensive collecting a rich material for future study. This was completely achieved thanks to the great wealth of the Javanese fungous flora, particularly at Tjibodas.

Prof. H. FITTING from Tübingen remained from October 1907 until April 1908 and investigated the influence of the pollen on the flowers of orchids. The principal aim of these researches was to analyze the changes of the parts of the flower which are produced by the pollination and to determine the factors to be considered. This aim was achieved in a satisfactory way. He also made numerous observations upon the stipular organs at dorsiventral branches of tropical plants and the relations between epiphyllic lichens and the leaves on which they occur. Furthermore he made studies of Hymenolichenes at Tjibodas; of the development of some tropical fruits; of the latex system of the most important rubber-producing plants; the relation of that system to the secondary growth and its regeneration after severe wounding and on the influence of the tapping cuts on the transport of food in the stem of *Hevea*.

Prof. G. TISCHLER of the University at Heidelberg occupied himself from August until December 1908 with the biology and the developmental history of the pollen of some species of *Cassia*; researches on the roots of mangroves and orchids especially with reference to the statolith-theory of geotropism; the cause of the sterility of *Musa* and *Ananassa*; the amylum content of the pollen of some tropical plants, particularly in anemophilous plants and the significance of Leguminosae, which gather nitrogen, for the crops cultivated on a large scale in Java (coffee, tea, cacao, guttapercha, rubber, coconut).

Prof. M. SIEDLECKI of the University of Krakau worked during the months January until June 1908 in the Zoological laboratory. He studied mainly the adaptation of the tropical fauna to tree life and investigated therefore the development of *Draco*, *Ptychozoon* and *Gecko*. Further he devoted himself to the embryology of a species of *Rhacophorus* which study brought to light very remarkable facts.

## 1908—1909

Dr. H. VON BERENBERG-GOSSLER, a German naturalist and surgeon, worked from October 1908 until March 1909 in the Zoological laboratory on histological and embryological subjects.

Prof. W. MAGNUS from Berlin stayed only a few weeks at Buitenzorg (February 1909) and occupied himself chiefly with the collection of galls produced by plant or animal organisms.

Prof. W. ARNOLDI from Charkow and his assistant S. L. STRELIN remained in Netherlands India for about five months (January—June 1909). During their stay they brought together a rich collection of demonstration material. The first-named continued his studies on the algae for which a good opportunity presented itself during a trip with the research vessel "Gier" to the "Duizend eilanden." For the same purpose he undertook a voyage to the Aru Islands.

Dr. K. DOMIN, lecturer at the University of Prague, interrupted his voyage to Australia for three months from August until November 1909 to obtain a knowledge of tropical plant life at Buitenzorg and Tjibodas. A special study of the stipular formations was undertaken, many new observations being made.

Prof. W. ROTHERT from Riga remained from January until November 1909 and during this time he made many trips through the Archipelago. Staying twice at Tjibodas he brought together a fine collection of Hymenophyllaceae. Further he accompanied Dr. ARNOLDI to the "Duizend" and Aru Isles and studied more in detail the mangrove of Nusa Kembangan. At Buitenzorg he occupied himself with the systematic anatomy of the *Dracaenas* and the *Cordylines*. Moreover, much material was collected for different scientific institutes.

## 1909—1910

Prof. Dr. H. MIEHE of the University at Leipzig arrived at Buitenzorg September 1909 staying till March 1910. He occupied himself especially with the following investigations:-

The biology of *Myrmecodia echinata* and *Hydnophytum montanum*, particularly in view of the biological significance of the tubers of these so-called "myrmecophilous plants"; microbiological investigations on the humus of epiphytic ferns and orchids, the micro-organisms occurring therein being examined on their ability to attack cellulose and to assimilate nitrogen.

Further he worked on the organ sensitive for light of a small fish often found in the water of rice-fields and the structure of the climbing organs of plants belonging to the genus *Randia*.

Dr. J. KUYPER from Utrecht, sent out by the Dutch Buitenzorg fund, stayed in Netherlands India from January until June 1910. Though he came with the main purpose to get acquainted with the tropical cultures he spent one and a half months in the laboratory for foreigners engaged in physiological research. He studied the influence of the temperature on the respiration of tropical plants chiefly in order to make a comparison between the peculiarities of the phenomenon here and in a temperate climate. Moreover, he occupied himself with a study of the shedding of the leaves of *Gonatopus Boivini*. Further embryological mate-

rial of some Pittosporaceae, *Nepenthes* and *Carica Papaya* was collected by him.

Dr. OSKAR WALTHER, TATIANA A. KRASNOSSELSKI, N. MAXIMOW and W. MALCEWSKI, all four from St. Petersburg, remained at Buitenzorg from June until August 1910 and devoted their time mainly to a research upon the presence of prussic acid in the growing points of *Bambusa*. Also anatomical and taxonomic demonstration material was collected by them.

### 1910—1911

Prof. Dr. G. KLEBS, professor of botany at the University of Heidelberg, studied during his stay at Buitenzorg from October 1910 until February 1911, the periodical phenomena of tropical plant life especially in connection with external factors. Numerous experiments and observations made by him led to the conclusion that periodicity of tropical plants depends on external and not on unknown internal factors ("Periodizität aus inneren Gründen" according to SCHIMPER). In connection with these researches studies were made about the problem of the periodical formation of wood in the tropics generally and that of Japanese and European trees growing in the mountain garden at Tjibodas particularly. A large collection of wood of cauliflorous plants was taken along to Europe to study the anatomical differences of vegetative and fructiferous branches. Of the subsidiary investigations made in Buitenzorg are to be mentioned:- the germination of seeds with an exceptionally hard seed-coat and the regenerative power of the seed-lobes; the development of some fresh-water Peridineae; Flagellates in ponds and rivulets at Buitenzorg and Batavia.

Prof. Dr. G. SENN, professor of botany at the University at Basle, stayed in the laboratory for foreigners five months, October 1910—February 1911, on account of the Swiss Buitenzorg fund. The physiology of *Trentepohlia* and other Chroolepidaceae was studied especially in view of the physiological significance of the lipochrome. This investigation gave interesting results e.g. with reference to the origin of the lipochrome and its nutritive value for the plant. The studies were continued in Europe with material sent by the laboratory. He also studied transversally heliotropic curvatures of the leaf-blade, a phenomenon observed in the leaves of *Drymoglossum piloselloides*, and later produced experimentally, and the reproduction of the Rhodophyceae especially of the genus *Polysiphonia*. This alga was found in fresh water on one of the coral islands in the bay of Batavia. These researches were also continued in Europe with material regularly sent from Buitenzorg.

For embryological investigations material of Annonaceae and Anacardiaceae was fixed and taken along.

Dr. S. V. SIMON, lecturer of botany at the University of Göttingen, investigated during his stay from October 1910 until July 1911 the periodical phenomena of tropical plant life. For this purpose the flowering, the development of the leaves, the formation of the annual rings, formation and accumulation of reserve substances, in a series of plants were studied. Besides this extensive investigation also other problems were tackled, namely:- the growth phenomena of the seedlings of *Bruguiera eriopetala* and the influence of the substrate on the anatomy of this and other mangrove plants; the regeneration of tapping wounds in *Hevea brasiliensis*, the influence of the tapping on the growth of the plant was studied simultaneously.

On request of the Ministry of the Colonies at Berlin Dr. SIMON also made a study of rice culture on Java.

Dr. W. F. BRUCK, lecturer of botany at the University of Giessen, came to Java in the first place as a delegate of the "Kolonial-Wirtschaftliche Komitee" at Berlin to the Fibre congress at Surabaya. His sojourn at Buitenzorg in the middle of 1911 in the Foreigners' laboratory he spent chiefly to collect material for further studies and for demonstration for the said committee.

Prof. Dr. G. VAN ITERSON, professor at the Institute of Technology at Delft, also came to Surabaya mainly as a delegate of the Dutch Government to the Fibre congress but devoted some time in August 1911 at Buitenzorg for research-work of a purely botanical nature. Some provisional observations were made on the decomposition of cellulose by aerobic bacteria the fact being ascertained that this substance is oxidized by the same microbe as in the temperate zone.

At Tjibodas material of *Nepenthes* pitchers was collected for a more detailed study of the anatomical structure. Also a collection of economic plants and their products was brought together.

Prof. Dr. H. LECOMTE, director of the Botanical division of the "Musée d'Histoire Naturelle" at Paris, and his collaborator Dr. A. FINET stayed for five weeks, August—September 1911, at Buitenzorg.

Their work was chiefly in the field of taxonomy and was aimed, among other things, at the preparation for a more prolonged sojourn in French Indo-China.

Dr. C. F. MILLSPAUGH, director of the Botanical division of the Field Museum of Natural History at Chicago, during December 1911 brought together a large collection of flowers, fruits and seeds for the said institute.

R. SAKAI and F. SENBON, two Japanese botanists, also stayed in December 1911 and made a collection of economic plants for the Bureau of forestry at Tokyo.

Dr. D. DE LANGE, formerly connected with the Experiment station at Salatiga, before returning to Europe worked during the months of April and May 1911 in the Zoological laboratory and occupied himself with different forms of the fresh-water fauna.

### 1911—1912

Dr. A. H. BLAAUW from Utrecht having been granted the subvention of the Buitenzorg fund remained from November 1911 until March 1912.

In the first place his aim was to obtain a general impression of the tropical flora and to make minor researches. Some data were collected about the sleeping movements of *Poinciana*, *Phyllanthus* and *Mimosa pudica* which indicated in which way to study this problem in hothouses in Europe.

Further on he made colour-photographs of tropical life to use at lectures in Europe. Generally satisfactory results were obtained with Lumière's autochromatic as well as with plates of Dufay.

At Tjibodas a short study was made of the growth of the aerial roots of *Cissus papillosa*; mode of growth, distribution of growth, influence of light and shade on growth, the conditions for the formation of lateral roots etc. in the virgin forest were studied. On behalf of the Botanical laboratory at Utrecht embryological material of some Proteaceae and Icacinaceae was collected and a collection of fruits on formalin and dried seeds was brought together.

Prof. W. PATTEN, director of the Biological Department of the Dartmouth University (Hanover, N.H., U.S.A.), worked for three weeks, April and May 1912, especially on the anatomy and embryology of the arachnids and myriapods, more particularly concerning the nervous system and the organs of sense. Besides, a large collection of anatomical material was brought together for future investigation.

Dr. J. VERMOESEN, mycologist from the Congo colony, stayed at Buitenzorg from April until May 1912 and came mainly to study the injurious fungi of tropical crops. The material collected on his voyage through Java was worked out in the Foreigners' laboratory and special studies were made upon the germination of the spores of Ustilagineae.

Prof. Dr. H. VON BUTTEL REEPEN from Oldenburg making a voyage in charge and support of the Humboldt Academy at Berlin arrived at Buitenzorg in April 1912. His aim was among other things to investigate the social life of termites and other insects. He collected for this study a great many data and much material at Buitenzorg and Tjibodas.

Dr. H. BÜCHER, reporter for agricultural affairs of the Government of Kamerun (West Africa), returning from an official voyage to German New Guinea, wished to obtain an insight into the organization of the Department of Agriculture at Buitenzorg. Moreover, in the Foreigners' laboratory in July 1912 a study was made on the pollination and the causes of sterility of the oil palm (*Elaeis guineensis*) a subject about which nothing was known yet. Important data which should enable him to continue these researches with success in Kamerun were collected.

### 1912—1913

Prof. A. NATHANSOHN occupied himself from October 1912 until February 1913 mainly with the gathering of materials and data for his work on the "Phylogenetische Morphologie der Angiospermen." As he was, however, not able to ac-

complish this work according to his original plan, he had the intention to revisit Buitenzorg.

Dr. W. KARAWAIEW, a Russian zoologist, visiting for the second time the Botanical Garden at Buitenzorg, remained from December 1912 until January 1913. His researches were chiefly in the field of myrmecology. At Buitenzorg and on various trips an extensive material was brought together and among the large number of species some new ones were detected. During a voyage to Ambon and the Aru islands, regions which are *terra incognita* from a myrmecological standpoint, much material which will be worked out later monographically was collected.

Dr. J. NAUEN of the "Höchster Farbwerke" during the month of February 1913 made an investigation into the origin of indigo in *Indigofera*. These studies were of a purely chemical nature.

G. SCHAEFFER, making a voyage in charge of the "Institut international d'agriculture" at Rome, studied tropical crops at Buitenzorg from February until April 1913, and worked in the Foreigners' laboratory on some plant-diseases and collected material on this subject.

Prof. Dr. V. N. LUBIMENKO, director of the Imperial Botanical Garden at Yalta (Crimea) stayed at Buitenzorg for two months, March—May 1913. Researches were made upon the formation and the occurrence of chromatophoric substances in different plants. He studied mainly the formation of yellow and red colours in fruits and in some definite parts of vegetative organs. Further an investigation was made into the maximum quantity of chlorophyll produced by the action of various factors (light and temperature) in tropical plants. For this purpose about sixty species of plants were examined spectroscopically and microchemically, the quantity of chlorophyll in the leaves being determined by the spectrocolorimetric method.

W. P. THOMPSON was able to work in the laboratory from January until May 1913 by a grant from a fund of the Harvard University at Cambridge (U.S.A.). He investigated the genus *Gnetum* morphologically as well as biologically and gathered a large collection of different developmental stadia of male and female flowers in order to study the pollination and fertilization. For more precise studies on the cytology of the embryo-sac much material was fixed. Also different dicotyledonous plants were investigated anatomically on their phylogeny, *e.g.* Piperaceae, Magnoliaceae etc.

Dr. J. DOPOSCHEG-UHLÁR, assistant at the Botanical laboratory of the University at München, studied during his stay from April until July 1913 the following problems:- the cleistogamy, especially of *Ruellia tuberosa*; the regenerative power of seedlings of the mangrove; the anisophylly in the genus *Piper*; different biological characteristics of swamp and aquatic plants; the vegetative development of the flowers of *Opuntia pubescens*. Moreover, plants and materials were collected for the Botanical Garden and the Laboratory for plant-physiology of the University at München.

F. P. JEPSON, Government entomologist at Suva, Fiji islands, stayed five months at Buitenzorg, from February until July 1913. His chief aim was collecting and possibly sending to the Fiji islands the natural enemies of *Cosmopolites sordidus*, a beetle causing much damage to the banana culture on the said islands.

Mr. JEPSON discovered in Java as the principal enemy of *Cosmopolites* another beetle, *Plaesius javanus*. By experiment the beetles kept in moist soil proved to be able to live about 130 days without any food; therefore a great chance existed that a large number of these beetles, if sent to Fiji, should arrive alive. Still other enemies were found in Java, a.o. *Chrysopila ferruginosa*, *Leptochirus tridens*, *L. unicolor*.

### 1913—1914

Miss Dr. J. WESTERDIJK, director of the Phytopathological laboratory "W. C. Scholten" at Amsterdam, came in October 1913 sent out by the Buitenzorg fund and stayed in Java until June 1914. She occupied herself chiefly with the collection of material of plant-diseases of tropical crops. Consequently Miss WESTERDIJK spent a great deal of her time visiting estates; besides, diseases and pests were studied at the various experiment stations. However, the Foreigners' laboratory remained the centre where different important injurious fungi were cultured and where the collections were arranged. A more special study was made of a *Hymenomyces* bearing sclerotia which is very detrimental to numerous cultivated plants.

H. A. GLEASON, assistant-professor of botany at the University of Michigan, visited Buitenzorg and Tjibodas from December 1913 until February 1914. He spent his time mainly on a survey of tropical plant-life and the culture and the use of food crops. Further he brought together much photographic and other material for educational purposes.

B. E. QUICK, also from Michigan University, investigated in February 1914 the physiological and ecological significance of the leaves and the sporophylls of *Drymoglossum heterophyllum*. He also made many photographs and collected material concerning plant ecology.

Miss Dr. L. WERNER from Berlin during 1914 studied the embryology of orchids and used her stay at Buitenzorg to make researches into the pollination and fertilization of various species represented there. Moreover, much material was fixed for future cytological investigation.

Prof. Dr. O. PORSCH, professor at the University at Czernowitz (Austria-Hungary), devoted his stay of four months, February—June 1914, chiefly on a study of the biology of different tropical plants. Much demonstration-material was collected for lectures, as well as for his own investigations, namely comparative morphological-phylogenetic studies, material of various plants. Further on he was interested also particularly in the following problems:- the morphological and physiological-anatomical adaptations of tropical flowers to the pollination by bees and birds; the structure of different flowers to prevent autogamy; the comparative morphology of the floral cnetaria in connection with their phylogenetic position; the phylogeny of the flower of the Aristolochiaceae.

Dr. H. CAMMERLOHER collected material for scientific researches in Europe from February until May 1914. In the first place he was interested in the developmental history of *Sciaphila*; the androgynophore of some Capparidaceae; investigations on the flower of some Annonaceae. As demonstrator of Prof. Dr. PORSCH he assisted him in the collecting and preparing of plant material; further he made a great many photographs of interesting plants.

Prof. Dr. J. WALTHER, professor of geology at the University of Halle, remained at Buitenzorg about two months, September—October 1914, and studied the formation of laterite.

Prof. Dr. E. GOLDSTEIN, professor at the University of Berlin, who like Prof. WALTHER stayed some time at Buitenzorg on his home-voyage from Australia to Europe, made investigations in the Foreigners' laboratory on the influence of sunlight upon certain argentiferous salts.

### 1914—1915

Dr. K. ZIMMERMANN, zoologist and teacher at the "Kaiser Wilhelmschule" at Shanghai, arrived in 1914 continuing also in 1915 his studies on the anatomy of the light-receptive organ of *Haplochilus panchax*, a small species of fish common in stagnant water.

D. T. FULLAWAY, entomologist of the Experiment station at Hawaii, came to Java in 1915 for the special purpose of studying the parasites of fruit-flies. These insects cause much damage in Hawaii and by their activity the fruit-growing there has so much declined that a special investigation of the natural enemies of these noxious insects became necessary. He spent his time at Buitenzorg collecting data about the life-history of a number of animal species which probably could be introduced into the Hawaiian islands as parasites of the fruit-flies.

Prof. Dr. A. LEBER, professor of medicine at the University of Göttingen, stayed at Buitenzorg from July until August 1915 and was mainly interested in the medicinal herbs of the natives, material and data of which were collected. A collection of edible fruits and spices was also brought together. Prof. LEBER occupied himself, moreover, with gathering statistical data on the nutrition of the people, and the biology and pathology of the free and indentured labourers on the estates.

### 1915—1916

F. BLEY, a student of botany at Zürich, worked a long time from August 1915 until February 1920 in the Treub laboratory on the embryology of *Laurembergia*, a marsh-

plant of the Dieng plateau, a thesis for a doctorate under Prof. ERNST at Zürich.

Miss C. SLUITER was enabled by a grant from the Buitenzorg fund to work in the Treub laboratory from September 1915 until April 1916. She undertook as a special research the study of fungi occurring in the soil. For this purpose samples were taken with sterilized soil drills of as many kinds of soils as possible from West, Central and East Java. Of the inoculations made in the laboratory various species of fungi could be isolated, a provisional survey of the different mycoflora's being obtained.

Besides these researches Miss SLUITER intended to obtain an insight into the tropical flora and crops for which purpose different experiment stations were visited. To study the flora trips were made to the Dieng plateau, the mangrove of Tjilatjap and the island of Nusa Kambangan, Tjibodas, Garut and environments, the Tengger mountains and the Idjen plateau. Being charged by the Institute of Tropical hygiene at Amsterdam she occupied herself, moreover, with the culture of fungi parasitic on men.

C. GRAVENHORST, a Danish chemist from Aarhus, worked from December 1916 until January 1917 in the Treub laboratory as well as in the Herbarium with the aim of getting a thorough knowledge of the taxonomic and other characters of the oil-containing seeds of various jungle trees, particularly trees belonging to the families of the Dipterocarpaceae and Sapotaceae. Employed by a commercial enterprise ordering great quantities of raw materials from Borneo for the oil industry and having to contend always with many difficulties resulting from the ignorance of the botanical origin etc. of the said material, he was convinced that a previous exact study only could solve these difficulties.

J. VAN BAREN, director of the Geological institute of the Agricultural college at Wageningen, made for the Dutch Government a geological study tour to Java between August and December 1916. He made his chief study of the tropical weathered soils and for the arrangement of his collections a place in the Treub laboratory was given to him.

### 1917

Prof. Dr. G. A. MACCALLUM of the University of New York investigated in 1917 the occurrence of parasitic worms in different tropical reptiles. An interesting material was collected to be worked out by him later on.

Prof. Dr. KEITA SHIBATA of the University of Tokyo continued during some weeks, January—February 1917, in the Foreigners' laboratory his investigations on the occurrence of flavones in tropical plants, already commenced in Japan. Moreover, during various trips through Java he collected materials of cultivated and pharmaceutical plants.

Dr. MITSUNAGA FUJIOKA of the Forest Experiment Station at Tokyo was principally interested in different physiological problems concerning the tropical virgin forest. As the chief of the Botanical laboratories had occupied himself during a long time with the physiology of the tropical jungle, trips were made in his company to acquaint Dr. FUJIOKA with the peculiarities of the virgin forest.

Dr. P. A. A. F. EYKEN studied by order of the Chief Inspector of the Civil Health Department at Batavia the biological purification of the Great Pond in the Botanical Garden. For some time, July—August 1917, he had an opportunity to investigate the great purifying power of the said pond; bacteriologically as well as chemically the results were surprising.

### 1919—1920

Miss H. C. C. LA RIVIÈRE of the Botanical laboratory at Leyden was sent out by the Dutch Buitenzorg fund remaining at Buitenzorg from December 1919 until September 1920 and making studies of the anatomy of the lianas. Her chief aim was to collect material and to make a provisional survey for future more detailed study at Leyden. Further, various trips were made e.g. to Tjibodas, Garut, Tjilatjap and the Tengger mountains to get acquainted with the tropical flora.

Dr. W. SEIFRIZ from Baltimore worked in the laboratory from September until November 1920 studying the phenomena of periodicity in tropical plants.

To Prof. Dr. E. NEWTON HARVEY of Princeton University hospitality was granted during the second half of 1920 in the Laboratory for marine investigations at Batavia to collect marine luciferous organisms. With the research-vessel a short trip was made for collecting *Pyrocypris*.

At Buitenzorg he studied also some luminous terrestrial animals.

Dr. W. BOBILIOFF, physiologist for the rubber culture, worked in the Treub laboratory from 1917 until 1920 and made the following investigations on *Hevea brasiliensis*: on amylum; the origin of the latex by reason of experiments with girdled trees; some data about the renovation of the bark; on the correlation between the production and the number of rows of latex vessels; on the transpiration.

F. BLEY, who had investigated from 1915 on with different interruptions in the laboratory the embryology of *Laurembergia javanica* left Buitenzorg in March 1920 to finish his studies in Switzerland.

W. CORNELIS made use four times of the research-vessel of the Laboratory for marine investigations at Batavia in 1920. He tried to ascertain the position of the rests of old riverbeds at the bottom of the Java sea by a survey of the profile of the sea-bottom with an instrument constructed by him and mounted aboard the vessel.

### 1920—1921

Dr. A. RANT, temporarily adjoined to the Director of the Botanical Gardens, made use of a place in the laboratory for the culture of fungi. He occupied himself mainly with an investigation of the Ambrosia fungi of the termites and the root tubers of *Casuarina equisetifolia* and *C. montana*.

Dr. RANT was appointed in June 1921 as teacher at the School for Indonesian physicians at Surabaya.

C. VAN ZIJP, pharmacist from Malang, was acting temporarily during the leave of Dr. VON FABER in 1920 and 1921 as chief of the Botanical laboratories. He made several microchemical researches and investigated Javanese beetles on cantharidin; he succeeded in demonstrating its presence in *Horia debyi* and *Cissites maxillosa*. A short article on this subject was published in the journal "Treubia." A method was worked out to localize the aluminum in plant tissues and to use benzidin-hydrochloride as a reagent on ligneous elements instead of phloroglucinol. Besides these studies he occupied himself with the collection of data and material of some Zingiberaceae, of Chinese drugs, and various itching hairs which are of importance from a forensic point of view.

Dr. O. ARRHENIUS of the University at Stockholm studied in 1921 the acidity of cultivated soils, especially rice-fields. Further he worked on the influence of the concentration of hydrogen ions on the life of earthworms. Observations were made upon the carbonic-acid content of the atmosphere in different plant associations, the correlating factors, light intensities and the formation of humus being also studied. He investigated also the osmotic pressure in different plants and worked out a new method to determine this pressure.

Materials for cytological, anatomical, bacteriological and phytochemical researches were taken along to Sweden.

### 1921—1922

Dr. C. YAMPOLSKY of the Columbia University of New York and former assistant at the Rubber Experiment Station at Medan, Sumatra, made an investigation from October 1921 until April 1922 upon the development of the leaves, the morphology and the anatomy of *Elaeis guineensis*. Further he studied the different varieties of this oil palm.

Dr. HJ. JENSEN of Copenhagen, who joined the Danish expedition to the Kei islands, worked at Buitenzorg in January and June 1922 on the preparation of the material destined for the museums in Denmark.

Dr. TH. MORTENSEN arrived in January 1922 as the leader of the Danish expedition to the Kei islands, sent out by the Rask-Ørsted fund at Copenhagen. Also after the ending of the expedition material of Phorids and pseudoscorponids was collected at Buitenzorg which, together with material of the same groups from Amboina, Kei and Banda, shall be worked out by Danish and Dutch specialists.

Moreover, some observations were made on pseudocephalic moths and mimicry and much material for the Copenhagen museum was brought together.

Dr. MORTENSEN was the first foreign guest in the new laboratory for marine investigations at Batavia. After his return from the Kei expedition he devoted himself in July and August 1922 to the artificial fertilization of various Echinoderms which were collected by help of the motor boat.

Dr. H. BOSCHMA, zoologist, arrived in October 1920 from Amsterdam and aided by the Buitenzorg fund he remained until September 1922 in Netherlands India. During the second half of 1921 he was in charge of the Treub laboratory while Dr. VON FABER was still on leave.

He spent his time in collecting the larvae of frogs, embryos of crocodiles and data about the coral-reef formation. In the first place he investigated the nutrition of the coral polyps, it becoming obvious that symbiosis of the coral polyps with zooxanthellae is of the highest importance. On the island of Edam in the Batavia bay the budding of corals was studied and much material collected, budding being also obtained by experiment. Observations were made about the variation of the colonies of reef corals in connection with different factors of growth. For other researches much other zoological material was brought together. At Tjibodas a study was made of Anura larvae and the peculiar mouth apparatus of the larva of *Megalophrys montana*.

From January until July 1922 Dr. BOSCHMA attended as a guest the Danish expedition to the Kei islands.

### 1923

Prof. Dr. TH. J. STOMPS, professor of botany at the University of Amsterdam, occupied himself from June until September 1923 chiefly with the fixation of material for embryological and cytological investigations. Much material has been collected further for the Amsterdam herbarium and museum. Prof. STOMPS spent a great deal of his time at Buitenzorg and in Java generally in visiting the botanical garden and the mountain garden at Tjibodas, Bandoeng and environments, Garut, Central Java, Pasuruan, the Idjen massive, the Tengger mountains, the south coast and the coral-reefs in the bay of Batavia for the purpose of getting acquainted with the flora of Java. Also a voyage through Sumatra was made. As a matter of course he interested himself mostly in the phenomena of variability of tropical plant life.

Mrs. Dr. THEKLA R. RESVOLL of the Botanical laboratory of the Christiania University remained in Java from November 1923 until January 1924. The main object of her sojourn was to obtain a general idea of the tropical flora. In connection with her studies on the mountain vegetation of Norway she devoted herself mainly to the flora of the volcanoes. In the Treub laboratory she occupied herself with an investigation upon the structure of leaf-buds, chiefly of plants occurring in the rain forest.

### 1924—1925

H. NAKANO twice paid visits to Buitenzorg, once in February 1924 on his way from Europe to Japan and for the second time during May and June of the same year. He occupied himself repeating the experiments made by STAHL on the attenuated leaf tips.

Prof. Dr. K. VON GOEBEL, professor of botany in München, stayed from September 1924 until January 1925. In the year 1885 Prof. VON GOEBEL paid his first visit to the laboratory for foreigners and various publications have been issued by him on the biology of tropical plants. In 1924 he studied different other biological subjects and made researches on the movements of the leaves of *Leersia hexandra*, on the phenomena of sexual dimorphism of inflorescences, the morphology of the inflorescence of Urticaceae, the collecting and economy of water by lichens, the dispersal and biology of Javanese liverworts.

Prof. Dr. H. WINKLER of the University of Hamburg also visited for the second time Netherlands India from September 1924 until March 1925 with the main purpose to collect material for the Hamburg museum. At Buitenzorg he brought together also material for cytological and morphological investigations. In the beginning of November he set out for an expedition to the Schwaner mountains in West Borneo and collected a great many plants. After his return he spent his time mainly preparing this material.

Miss Dr. L. MÜLLER from Bonn visited Java to get a knowledge of the tropical flora. For four months, until December 1924, she studied at Buitenzorg and Tjibodas the problem of the secretion of water by leaves and flowers of tropical plants.

Dr. O. POSTHUMUS from Groningen sent out by the Buitenzorg fund remained about the whole year 1925 in Netherlands India making many excursions on Java and joined an expedition to Djambi for the collection of paleobotanical material. At Buitenzorg and Tjibodas he occupied himself with an investigation upon the internal structure of some Polypodiaceae not yet studied. Furthermore he collected much material for future study of this subject and paleontological material among which a collection of petrified wood from Bantam.

Dr. B. H. DANSER came in 1925 aided by the Buitenzorg fund and devoted himself to taxonomic and genetic studies and made experiments on the hybridization of *Stachytarpheta*-species. Afterwards he remained for some years temporarily connected with the Herbarium at Buitenzorg.

A. J. P. OORT, a student of Utrecht who stayed eight months, until March 1925, and Miss D. SORGDRAGER of Amsterdam University, paid a visit to the Treub laboratory.

They used their time in the botanical garden at Buitenzorg as well as in the forest of Tjibodas to get an insight in tropical nature. Mr. OORT investigated in the Treub laboratory also the formation and disappearance of amylum in leaves in connection with evaporation.

### 1926—1927

Prof. R. NAKAZAWA, mycologist of the Institute for experimental researches in Formosa, stayed at Buitenzorg in March 1926 and made mycological investigations.

G. FAIRCHILD Jr. remained from April until May 1926 and collected much material for entomological studies.

Prof. Dr. B. B. MARCOVITCH, chief of the subtropical division of the Institute of applied botany at Leningrad, paid a visit to Buitenzorg during August and September 1926 making a study of tropical crops.

Prof. K. ROUPPERT, professor of botany at the University of Krakow, worked at Buitenzorg from April until October 1926 with the support of the International Education Board of Rockefeller Jr. He studied mainly the following problems: the formation of tubers by different phanerogams; the relation of plants and ants; the extracellular oxidizing ferments in the phanerogams.

Prof. J. W. HARMS, professor of zoology at the University of Tübingen, arrived with two assistants, Dr. B. EGGERT and H. FRIEDRICH, early in September 1926. In the laboratory for marine investigations at Batavia they studied various subjects, a.o. the propagation of *Periophthalmus* and *Boleophthalmus*. On account of ill-health Dr. EGGERT was compelled to return rather soon to Europe. Prof. HARMS and Mr. FRIEDRICH remained until March 1927; so did Mr. F. WEYER who came to Java in the end of December 1926 to take Dr. EGGERT's place. Prof. HARMS investigated further among other subjects the biological problems of the coastal fauna of Java and islands off the coast; the morphology and physiology of *Lingula* and the relation between the senescence and the internal secretion in apes.

Misses H. VAN BLOMMESTEIN and C. J. TONKES, both students of the University of Utrecht, worked in the Treub laboratory from January until April 1927 and studied various plant families. For the same purpose they visited also Tjibodas for some time.

Dr. J. H. F. UMBGROVE and Dr. J. M. v. d. VLERK of the Geological Survey at Bandung stayed for some time at the Laboratory for marine investigations at Batavia making studies of coral-reefs and the occurrence of foraminifera.

Prof. Dr. H. BURGEFF of the University of Würzburg investigated from October until the end of the year 1927 different saprophytes and found the occurrence of a symbiosis of orchids with bacteria beside the mycorrhiza, both symbionts inhabiting different or the same organs of the plant. Researches in Europe will elucidate the physiological relation between symbionts and higher plants. Also various Hepaticae were collected for genetical researches.

### 1927—1928

Dr. G. L. FUNKE, teacher at the gymnasium of Schiedam, aided by the Buitenzorg fund, studied from November 1927 until March 1928 the biology and anatomy of leaf-shedding Leguminosae and the anatomy of different families of lianas. He made observations on the longitudinal growth of climbing Araceae, the leaf joints of various plants, heterophylly of Piperaceae, and investigated the physiological characters of two different races of *Aspergillus oryzae*.

Prof. Dr. H. KNIEP of the University of Berlin was enabled by the German tropical fund for botanists to work in Buitenzorg for five months, from November 1927 until

March 1928. The following researches were made by him:- the propagation of *Phytophthora Faberi*, especially the relation between the mode of life on certain host-plants and the formation of zygotes; the sexuality of the Auriculariaceae; further he occupied himself with the culture of Javanese water fungi (Saprolegniaceae and Blastocladiaceae), of *Tulasnella*, the pure culture of Ustilagineae and searched for the conditions by which copulation is achieved; the isolation of both the components of the Hymenolichens; moreover, he investigated the conditions of germination of seeds of cosmopolitan plants, especially of weeds.

Miss Dr. M. ZUELZER of the Government Health Department at Berlin stayed from April until May 1928 in the laboratory at Buitenzorg studying the occurrence of protozoa in plants, chiefly those in latex-containing plants.

### 1928—1929

Prof. Dr. H. VON GUTTENBERG of the University of Rostock arrived in November 1928 and remained until March 1929. The object of his researches was to ascertain both quantitatively and qualitatively the assimilation of tropical plants. Time, however, proved to be too short to solve this extensive problem satisfactorily, so the assimilation of a few types only could be determined and material for future researches could be collected. Another subject studied by him was the inflorescence and the flowers of Zingiberaceae, Gesneriaceae, Araceae a.o., especially in view of the secretion of water. Further studies were made on the developmental history of the leaf-tips of *Dioscorea* and *Smilax* species, mycorrhizae, cytology and development of the arillus, the mechanism of the opening of fruits, geotropism of the roots of orchids, hydathodes of ferns, fungous galls, and phanerogamous parasites. For all these investigations much material has been brought together.

Prof. Dr. KWAN KORIBA of the University of Kyoto, Japan, after attending the Fourth Pacific Science Congress worked for some two weeks, June 1929, in the Treub laboratory. He investigated the transpiration of cut leaves of epiphytes.

Prof. Dr. A. THIENEMANN of the Hydrobiological station at Plön (Holstein), Prof. Dr. F. RUTTNER of the Hydrobiological station at Lunz (Austria), Prof. Dr. H. J. FEUERBORN of the Zoological institute of the University at Münster, remained in Netherlands India from September 1928 until the end of July 1929. The aim of their voyage was the limnological research of the tropics. Besides Java also Sumatra and Bali were visited. The brooks and ponds of the Botanical Garden and the lake of Tjigombong were investigated in the first place, then different lakes in East Java in the neighbourhood of the Lamongan were the next objects and further those of Sarangan and Ngebel. The conditions of life, the chemical composition, the temperature, the sedimentation and the life-history of the organisms occurring in the lakes, rivers, brooks and springs in Java, Sumatra and Bali were studied. A more exact examination and preparation of the material collected at the various localities took place in the Treub laboratory.

On the occasion of the Fourth Pacific Science Congress held in May 1929 in Java the Laboratory for marine investigations at Batavia was visited by many members of the said congress.

Dr. TH. MORTENSEN of the Zoological museum of Copenhagen stayed before the congress a few weeks on the island of Onrust and occupied himself with the culture and study of echinoderm larvae.

Dr. H. BOSCHMA from Leyden performed some investigations after the congress during a month on reef corals while awaiting the departure of the Snellius expedition.

### 1929—1930

Dr. O. STOCKER from Bremerhaven studied from October 1929 until March 1930 the assimilation and evaporation of sun- and shade-leaves and some herbs. In connection herewith an investigation was made upon the variation in the carbon dioxide content of the air at Buitenzorg and Tjibodas. Further a number of excursions were made to obtain a general survey of the plant-geography and associations in the tropics.

Dr. G. KJELLBERG from Lidköping, Sweden, used in April 1930 a work-table in the Treub laboratory having spent about the whole year before in Celebes to study the flora of that island.

FR. VERDOORN of Utrecht remained from April until September 1930 and collected in Java and Sumatra various bryophytes especially in view of the revision and study of the variability of the Frullaniaceae and Lejeuneaceae.

### 1930—1931

Prof. Dr. G. BLUM from Freiburg (Switzerland) stayed from August 1930 until March 1931 in Java and investigated at Buitenzorg the suction force, the evaporation and osmotic pressure of a great many tropical plants.

Prof. Dr. O. RENNER, professor at the University of Jena, studied during his stay from November 1930 until March 1931 the water intake of epiphytic algae, mosses, lichens and ferns; the transportation of water by aerial roots; the biology of fern sporangia; the wax glands of *Ficus* visited by ants.

Prof. Dr. A. ERNST from Zürich visited Java from November 1930 until March 1931. He investigated the pollination and fertilization of heterostylous Rubiaceae in connection with his former researches on the same subject. Further he examined the fructification of *Caulerpa* species discovered by him for the first time in tropical forms of this genus. He collected also much material for embryological and cytological researches of parasites and saprophytes to be worked out after his return to Europe. In connection with his visit to Krakatau 25 years earlier he made anew a trip to this island.

Mrs. Dr. M. ERNST-SCHWARZENBACH worked together with her husband and made herself a large collection of cytological material, especially of palms, and cultured heterosporic mosses.

Miss Dr. B. POLAK from Amsterdam, sent out by the Buitenzorg fund, stayed from February 1930 until June 1931. The chief aim of her visit was to get an insight into the problem of the formation of peat in the tropics. Besides different localities in Java, the forest swamps in Sumatra and Borneo were visited.

Miss E. GRACE WHITE from Wilson College, Chambersburg, Pa. (U.S.A.), stayed only a short time, March—April 1931, at the Laboratory for marine investigations at Batavia making comparative anatomical studies of the Plagiostomes.

Miss Dr. A. G. STOKEY, professor of botany at South Hadley, Mass. (U.S.A.), worked in the Botanical laboratory from May until July 1931. She studied the germination of fern spores and the development of the prothallia especially those of representatives of more primitive families.

Prof. Dr. R. BOUILLENNE, director of the Botanical institute at Liège (Belgium) and Mrs. M. BOUILLENNE remained from April until November 1931. Prof. BOUILLENNE devoted himself mainly to the study of the interna and external factors influencing the formation of roots.

Mrs. BOUILLENNE performed in collaboration with Dr. KOOLHAAS, chief of the Phytochemical laboratory, some researches on the toxicity of the seeds of *Pachyrrhizus* and of rotenone, the active principle of the Derris root.

Dr. M. OGATA from Tokyo spent his time, August—November 1931, chiefly in collecting Javanese ferns.

Dr. C. A. GEHLSEN, formerly a German planter in Java, stayed only a short time at Buitenzorg, September—November 1931, examining the formation of roots in inverse cuttings.

Miss J. COLLIER of the Department of Tropical Medicine at Boston worked for some weeks in 1931 in the Zoological Museum investigating the occurrence of protozoa in the intestines of termites and cockroaches in connection with the digestion of cellulose.

### 1931—1932

Miss Dr. L. E. VAN LUMMEL stayed from March 1931 until October 1932 on the island of Onrust and gathered observations on the periodical appearance of luminous worms and on the disappearance of algae in corals by darkness in connection with the significance of these algae as symbionts of the corals.

Prof. R. KOLKWITZ from Berlin remained from October 1931 until March 1932 in Java staying more than three months at Tjibodas. He occupied himself with a study of the algal flora of the water in connection with its mineralization; of atmophytic algae of the virgin forest and of marine micro-algae.

Prof. R. WOLTERECK, professor of zoology at the University of Leipzig, came to Buitenzorg after his voyage to

North Celebes and the Sanghi and Talaud archipelago for a short time, July 1932, preparing for a trip to Central Celebes. He paid also special attention to the plankton of the ponds in the Botanical Garden.

Miss Dr. A. KLEINHOONTE of the Laboratory for technical botany at Delft came for the Buitenzorg fund and remained from April until August 1932. In the Treub laboratory she examined the formation of latex in *Hevea* cuttings. Further she travelled in Java to obtain an idea of the flora as well as of the work of the experiment stations, the different crops and some technical businesses.

Prof. Dr. P. METZNER, professor of botany at Greifswald, worked at Buitenzorg from September 1932 until January 1933 and studied the sleeping movements of different tropical plants and non-tropical ones under tropical conditions. Moreover, he occupied himself with a study of epiphyllous mosses and lichens and the anatomy of dorsiventral aerial roots.

**1933—1934**

Prof. OUANG TE-YIO, professor of zoology at the University of Peiping, spent some weeks, June—July 1933, at Buitenzorg collecting material for the Natural History Museum at Peiping.

Prof. M. KOERNICKE of the Agricultural College at Bonn-Poppelsdorf visited Buitenzorg for a second time from August 1933 until February 1934. His first visit took place in 1906—1907. On this occasion he studied the dependence of the Loranthaceae upon their host-plants, the physiology of the germination of these parasites and the sexual ratio of *Carica papaya*. He made a long journey in Java, to the Celebes and Moluccas in order to get acquainted with the different forms of vegetation and the various crops.

Dr. F. A. SÜFFERT from Freiburg (Bavaria) stayed at Buitenzorg at the same time as Prof. KOERNICKE. The purpose of his visit was the study of mimicry and protective colours in tropical animals. Many peculiar examples could be observed and pictured, much material also for future investigation being brought along.

IVAR ELVERS, botanist from the University of Stockholm, occupied himself during his stay from December 1933 until April 1934 with the collection of material for cytological and embryological researches especially of Annonaceae and Myristicaceae.

Prof. C. E. MCCLUNG, director of the Zoological laboratory of the University of Pennsylvania, paid a short visit to Buitenzorg, in July 1934, having remained a year in Japan as visiting professor at Tokyo. He brought together cytological material of grasshoppers for the study of the relation between the properties of the germ-cells and those of the organisms developing from them.

Miss TH. FRÉMONT of the Institute Pasteur at Lille worked in the Treub laboratory for a few weeks, November—December 1934, after a voyage through California investigating mycorrhiza in *Citrus*.

Dr. A. STEINMANN, formerly connected with the Tea Experiment Station at Buitenzorg, stayed as a guest in the laboratory during 1933 and 1934. Besides an extensive study of plants and animals depicted on ancient Hindu monuments in Java he made also investigations upon the maturation of tropical fruits, especially the occurrence of acetaldehyd; on the mycorrhiza in Java in connection with the occurrence of *Rhizoctonia bataticola*; on adulterations and surrogates of tea, making further some ecological observations on phytoplankton in certain fresh-water lakes.

A work-table in the laboratory was also put at the disposal of Dr. A. RANT during 1934 after his retirement. He spent his time in culturing various termite fungi and the pure culture of Ustilagineae on rice and the witches' broom of *Melastoma malabathricum*; furthermore he made an investigation of the fructification of a cleistogamous plant, *Clitoria laurifolia*.

# A SHORT HISTORY OF BERI-BERI INVESTIGATIONS IN THE NETHERLANDS INDIES

*by*

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For nearly a century physicians in the Netherlands East Indies have been interested in beri-beri. Important contributions which ultimately solved the beri-beri problem have appeared in the "Geneeskundig Tijdschrift voor Nederlandsch-Indië" (Netherlands Indies Medical Journal). The first of these articles was published shortly after this Journal was established in 1851. From the articles it appears that as far back as 1854 beri-beri in the Netherlands East Indies was considered to be a "cosmic disease," a hybrid of febris intermittens and typhoid fever. Between 1860 and 1870 some clinicians saw an intimate kinship between the disease and rheumatoid arthritis, and warmly recommended massage as an effective cure. During the same period, discussions regarding the relationship of beri-beri with kidney disease and with pernicious anemia took place, and the possibility that an inflammation of the spinal meninges might underlie the beri-beri syndrome was considered.

In 1880 it was pointed out in the Dutch literature that dietary influences might be responsible. One author was of the opinion that beri-beri was due to dried fish imported from China, while other clinicians stressed their experience that the beri-beri patient recovered quickly when given a European diet, a fact which led them to believe that lack of proteins and fats was the main causative factor. Soon, however, interest in the possibilities of the nutritional etiology of beri-beri waned, and most authors devoted their attention to possible biological factors. The theory that intestinal worms, especially *Trichuris trichiuris* and *Ancylostoma duodenale*, might cause beri-beri was advanced and soon forgotten. About 1882 the possibility that the disease might be due to a miasmatic infection was freely discussed.

In view of the paucity of results achieved in combating beri-beri which was raging among the troops on active service in Achin, the government decided to send the biochemist PEKELHARING and the neurologist WINKLER from Holland to the Indies to study the problem. EIJKMAN, a young medical officer of the Netherlands Indies Army, was appointed assistant to these scientists. Acting as a committee, they "isolated" in 1887 a

* The Editors of "Science and Scientists in the Netherlands Indies" are under great obligation to Dr. I. SNAPPER, who kindly translated, condensed, and edited the authors' Report of 1938 to the League of Nations (Health Organization, Technical Commission, pp. 33, 1938).

special micrococcus as the causative organism and advised careful disinfection of all objects with which the beri-beri patient had come in contact. On the authority of these scientists the infectious character of beri-beri remained an accepted theory for several years.

There were, however, a few dissenting opinions. One was defended, around 1887, with great fervor by VAN DIEREN, a practicing physician in Amsterdam who had never been in the Netherlands East Indies and had never had any personal experience with beri-beri. He decided, after a critical historical survey of the literature, that the disease developed when people were fed on white milled rice. Although wrong in his contention that milled rice contained a toxic substance, his therapy was correct. He concluded from his study of the literature that beri-beri does not occur as long as the natives eat hand-pounded rice, "gabah," and that patients having the disease rapidly improve when fed with gabah. Unfortunately VAN DIEREN was no experimenter and had to found his theory by interpretations of the investigations of others. His correct conclusions as to therapy were severely criticized by the infectionists. In the ensuing battle of opinions, VAN DIEREN not only attacked the latter but for many years continued to defend his toxin theory against the new discovery that beri-beri was a deficiency disease. Consequently, it is often forgotten that VAN DIEREN's therapeutic solution of the beri-beri problem was sound, although his theory as to etiology was fallacious.

There were very few other authors who rejected the infection theory. Between 1893 and 1896 it was generally accepted that acute beri-beri, especially, was highly contagious. The destructive effect of methylene blue on beri-beri bacteria was carefully described and various remedies, such as bapatjeda (Scaevola koenigh) and diuretin, were recommended for the disease.

EIJKMAN, in the meantime, had been appointed director of the newly established Laboratory for Pathological Anatomy and Bacteriology at Weltevreden after the departure of PEKELHARING and WINKLER. During the period of controversy between the supporters of the infection theory, those of the toxin theory, and the few who assumed that malnutrition was a partial cause of beri-beri, he energetically continued investigating the cause of the disease. In an article written in 1889 he concluded that, although no grounds existed for abandoning the infection theory, neither could any positive arguments be advanced in its favor.

In the following year appeared his well-known work on polyneuritis gallinarum and beri-beri, in which he drew attention to the great similarities and relatively small differences (even from the histological point of view) between chicken polyneuritis and human beri-beri. Carefully, step by step, he built up his dietary deficiency theory. In this classical publication he writes cautiously, "At the present time no facts are known which compel us to connect beri-beri with the diet as directly as would appear to be the case with chicken polyneuritis." EIJKMAN'S investigations were interrupted by illness, but in 1891 he resumed his work and showed that beri-beri in prisons was not caused by faulty drinking water. In 1892 he published a follow-up of his article on chicken polyneuritis, dealing at greater length with the pathological aspects of the disease.

In 1894 GRIJNS, who was to become one of the outstanding defenders of EIJKMAN's theories, was attached to the Laboratory for Pathological Anatomy and Bacteriology at Weltevreden.

In 1896 EIJKMAN again drew attention to polished rice as a cause of chicken polyneuritis. However, he then still assumed that a "poison" present in starch was the causative factor and that there were in or near the rice husk one or more substances which neutralized or destroyed the "poison." According to him, these "protective substances" (later known as vitamins) occurred not only in the husks of rice, but also in other foodstuffs, such as meat. He considered that the "poison" was not pre-existent in the milled rice, but assumed that it might be formed during passage through the digestive tract. Though he thought that the differences between the symptoms of human beri-beri and those of chicken polyneuritis were great, he clearly pointed out that his observations and the results of his investigations might be of use in revealing the cause of human beri-beri.

EIJKMAN's experiments in the Netherlands Indies were interrupted when, in March 1896, he was obliged to go to the Netherlands on sick leave. In 1898, while professor of bacteriology and public health at the University of Utrecht, he was still occupied with the experiments he had started in the Indies. In an article on beri-beri and diet, which in some ways may be regarded as the conclusion of his work in the Batavia Laboratory, he emphasized his theory that beri-beri was not caused by rice alone, as was commonly supposed, but also by sago. He therefore recommended that the main food in prisons should be unmilled rice.

Notwithstanding the numerous reverses he had experienced during his career in the Indies, partly because of unsatisfactory health, EIJKMAN built up his theory indefatigably and with utmost caution, basing his ideas on the results of his own observations and experiments rather than upon plausible hypotheses. In this respect he stood far above most of his contemporaries.

EIJKMAN was succeeded in the laboratory at Weltevreden by ROLL, with whom GRIJNS now became associated. GRIJNS continued EIJKMAN's experiments and, on the basis of his own observations, promptly denied the production of a specific beri-beri toxin. This was a further step in the direction of the dietary deficiency theory. However, it was many years before EIJKMAN gave up his theory that beri-beri toxin was produced from carbohydrates and was neutralized by the protective substances in foodstuffs.

In 1897 VORDERMAN, who had been of great service to medical science in other fields, published an excellent report showing clinical evidence that the use of polished rice as the principal article of human diet was followed by beri-beri, and that the substitution of unmilled rice caused the disease to disappear. EIJKMAN recognized the significance of VORDERMAN's clinical results in the light of his own observations on chicken polyneuritis. However, the conclusions of EIJKMAN and VORDERMAN were not generally accepted and various investigators advanced objections.

VAN GORKUM criticized the methods VORDERMAN had used in his investigations of the diets of prisoners. He refused to admit a connection between EIJKMAN's polyneuritis experiments and beri-beri, and continued to support the infection theory. GRAVENSTEIN, although refusing to go beyond admitting that a better diet had a beneficial influence on the course of the disease, was

able to show a clear connection between diet and beri-beri during an outbreak of the disease in the island of Titawaai. GRIJNS' experiments, which showed that the mungo bean (katjang idjo) acted as a preventive and as a remedy for chicken polyneuritis, failed to convince the opponents of the dietary theory; and in 1900 VAN DER SCHEER, an expert on tropical medicine, declared that, in many cases, diet could not account for the presence of beri-beri.

In spite of the differing opinions of other investigators GRIJNS continued his research. In 1901 he announced that chicken polyneuritis was not caused by a deficiency of proteins or salts, that fresh polished rice could produce beri-beri just as surely as polished rice which had been stored for a long time, that the fatty substances of the rice failed to prevent polyneuritis, and that the substances in rice husks which prevent polyneuritis were mostly lost or destroyed in the usual process of converting gabah (threshed but unhusked rice) into polished rice. Finally, he confirmed his former conclusion that some kinds of legumes (katjang) had a curative effect on chicken polyneuritis. Furthermore, he asserted that polyneuritis gallinarum was not due to any form of starch. Here he disagreed with EIJKMAN, who at the time still maintained that toxic substances probably were formed in the intestines from special kinds of starch. GRIJNS did not consider it necessary to assume the presence or the production of a toxin presumed to be neutralized by the "protective" substance.

After two decades of lively controversy (1880–1900), the supporters of various theories as to the etiology of beri-beri appear to have buried the hatchet temporarily, and publications on the cause of the disease became infrequent. One writer in 1903 attributed the various manifestations of beri-beri to poisoning by oxalic acid and certain organic substances which he thought were produced by fungi in the intestines. VAN GORKUM in 1904, after another survey of the current state of the beri-beri question, apparently still championed the infection theory.

Interest in the beri-beri problem revived after 1905, and both EIJKMAN's and GRIJNS' opinions appear to have gained ground steadily. The infection theory receded into the background, and the deficiency theory acquired more and more adherents, partly in consequence of HULSHOFF POL's experiments (1906–1907) which showed that GRIJNS' observations on the use of katjang idjo in chicken polyneuritis held good for human beri-beri. This conclusion soon afterwards was borne out by other findings, similarly based on observations of prisoners suffering from beri-beri.

An article by DONATH and SPRUYT on the protective action of various legumes and seeds of the Indies confirmed, in the main, GRIJNS' and HULSHOFF POL's investigations. The same conclusion was reached by JANSEN in connection with other foodstuffs rich in vitamin $B_1$.

The connection between polyneuritis gallinarum and beri-beri gradually became more evident as HULSHOFF POL's observations on the effects of aqueous extracts of katjang idjo in cases of human beri-beri were confirmed by GRIJNS and KIEWIT DE JONGE. At this stage, EIJKMAN's theory (as amplified by GRIJNS, HULSHOFF POL, KIEWIT DE JONGE, and others) that beri-beri is caused by dietary deficiency was generally accepted, but even EIJKMAN's colleagues disagreed about several details.

In 1911, GRIJNS tried without success to isolate the active principle of rice husks (dedek). His failure is not surprising in view of the limited facilities and methods at his disposal. He was, however, able to show that the anti-neuritic principal in rice bran was not, as was frequently supposed, *e.g.* by SCHAUMANN, made up of organic phosphorus compounds.

HULSHOFF POL contested once again the opinion that polyneuritis gallinarum was actually a form of "nerve-starvation" due to a deficiency of certain indispensable substances, either phosphorus or other compounds as yet unknown. He recalled earlier theories and, by feeding cocks with fermented boiled or unboiled rice, attempted again to discover whether micro-organisms or toxins might be responsible for chicken polyneuritis. He failed to reach any definite conclusions, finding only that fermented rice which subsequently had been washed would cause polyneuritis more readily than white rice which had been processed in the ordinary manner. Neither fermented rice water nor the organisms which produced the fermentation made the birds more susceptible to the disease.

GRIJNS, in another article, pointed out that HULSHOFF POL's experiments in no way contradicted the "nerve-starvation" hypothesis, even though nothing definite could as yet be stated concerning the substance lacking in the nerves.

GRIJNS persisted in his opinion that some dietary deficiency, and not a microbe, was probably the factor underlying both polyneuritis and beri-beri. At the same time EIJKMAN drew attention to the difficulties connected with the explanation of the apparent cures of pigeon polyneuritis by KCl, NaCl, and other substances.

After FUNK had introduced the notion of vitamins, the idea of "protective" substances gradually became familiar, and the theory of an unbalanced diet as the cause of polyneuritis gallinarum and beri-beri gained new ground.

In 1916 EIJKMAN was able to explain certain symptoms (concerned with inanition, etc.) which until then had been obscure, and which HULSHOFF POL and others had cited as evidence against the "nerve-starvation" (now modernized under the name "vitamin deficiency") theory. This was a great step forward, and thenceforth, in the Netherlands East Indies, beri-beri research and the study of vitamins were closely linked.

In the meantime, clinical evidence indicating the relationship between beri-beri and milled rice had increased rapidly. In 1911 and in 1913 studies of beri-beri among miners at Billiton, made over the preceding fifty-year period, demonstrated that a clear connection existed between beri-beri and the consumption of processed rice. At the same time, SCHÜFFNER and KUENEN published a scholarly and well-documented article in defense of unhusked and parboiled rice.

In 1916, other authors reported that the use of unhusked, unmilled rice and katjang idjo was effective in curing beri-beri in Javanese coolies on the East Coast of Sumatra, and that a diet of husked, unmilled rice, in place of polished rice, prevented the occurrence of the disease. Good results also were obtained in Sinabang by changing the diet of 800 hired coolies. In Balikpapan, a diet of husked, unmilled rice mixed with polished rice, and as much katjang idjo as possible in additional dishes, proved to be successful.

In 1918 it was pointed out that, while the vitamin deficiency theory was usually an adequate explanation of the occurrence of beri-beri, there were cases in which the vitamin deficiency theory

alone apparently was insufficient to account for the disease, as in the outbreak in Achin in 1897. The assumption that other complicating factors must be present continues to be accepted at the present time, and some factors in the etiology of beri-beri are still obscure.

At the same time, in a detailed report on the advantages and disadvantages of husked, unmilled rice as compared with polished rice, chloroform and carbon tetrachloride were recommended as preservatives for the unmilled kind. The $P_2O_5$ method for the determination of the beri-beri preventing properties of rice was found to be unsatisfactory, and a better method, based on the dry weight of the alcoholic extract of rice, was proposed.

It was emphasized that washing and steaming would deprive rice of its beri-beri preventing properties, a fact which has since become generally recognized. During the following years, JANSEN succeeded in perfecting a biological technique that enabled him, by means of animal experiments, to estimate the vitamin $B_1$ content not only of dedek and dedek extracts, but also of rice.

Notwithstanding the good results obtained with husked, unmilled rice as a means of preventing beri-beri, the use of this kind of rice in the army was temporarily abolished for technical and tactical reasons. As might have been expected, EIJKMAN at once opposed the move. He was of the opinion that polished rice, together with wholesome additional food, would not constitute for the Javanese, whose staple food is rice, a type of diet that would prevent beri-beri. He therefore predicted that the disease would break out, and his prediction proved to be correct. In 1921 and 1922, the number of beri-beri cases in the army had increased considerably, but a return to a diet of unmilled rice with an adequate $P_2O_5$ content had an immediate beneficial effect. Nowadays the technique of nutrition has progressed to such an extent that, since 1933, the army in Java has again returned to a diet of polished rice, together with additional food of especially good quality, apparently without any harmful effects, though such a diet is not the cheapest kind.

SCHÜFFNER entirely agreed with EIJKMAN, but at the same time he pointed out that husked, unmilled rice might be replaced by partially-polished rice which not only still contained an adequate amount of vitamin $B_1$ that could be assessed by means of the $P_2O_5$ test, but also had a much more attractive appearance. KOP published a short report in 1920 in which he maintained, contrary to CHICK's and HUME's statements, that properly boiled potatoes contain a considerable quantity of vitamin $B_1$, and accordingly he recommended that they be made the staple food for the army. His opinion was correct, provided the potatoes were properly boiled, *i.e.* not boiled too long or boiled down. His recommendation that boiled potatoes be made a staple food for the army was all right for that part of the army which would eat boiled potatoes; but as for the native troops, it was obviously an *a priori* impossibility, in view of their customs, to get them to eat potatoes as their main food in place of rice.

DE RAADT in 1921 and BIJLMER in 1924, during New Guinea expeditions, demonstrated the importance of a diet that would prevent beri-beri. The F.E.A.T.M. Congress, held in TOKYO in 1924, concluded that beri-beri must be included among preventable diseases. DE LANGEN in various reports pointed out that, as husked, unmilled rice was not suited for transport and storage, gabah (threshed rice) would be much better adapted for these purposes. His proposal to utilize the finest dedek (bekatoel), which is very rich in vitamins, involved practical difficulties that have not been overcome completely even at the present time.

After the fundamental work of EIJKMAN and GRIJNS had laid the foundations for the recognition of beri-beri as a vitamin deficiency disease and the clinical proof had been furnished by physicians of the Netherlands East Indies, another group of scientists in the tropical Netherlands succeeded in isolating the vitamin. JANSEN, after showing that secretin from gastric juice and vitamin $B_1$ were in no way connected, in 1920 described the first methods of extracting the vitamin from rice husks (dedek), and emphasized the varying vitamin content of dedek.

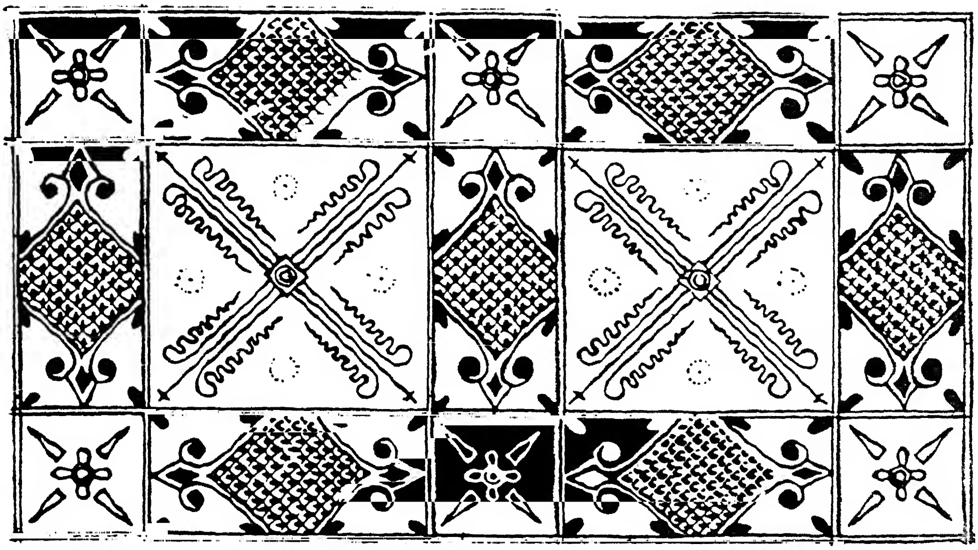
JANSEN used a kind of rice-bird (*Munia maja*) as an experimental animal and found it much more suitable than cocks or pigeons, or the glatiks (*Amadina oryzivora*) used by other investigators. In 1920, he and MANGKOEWINOTO showed that the respiratory quotient was often reduced in rice-birds (Java sparrows) deficient in vitamin $B_1$.

In 1923, JANSEN published a detailed article, of great importance even now, on the $B_1$ content of a large number of Indian foodstuffs. In 1924, he showed that the contents of vitamins A and $B_1$ and of enzymes and proteins was as great in hundred-year-old rice from Korintji (Sumatra) as in ordinary rice. He also indicated how to prepare, for various kinds of "State boarders," new diets that were more appetizing, more nutritive, and cheaper, with the result that over a million guilders was saved annually on prison diets alone, a possibility that so far had been insufficiently appreciated.

Later, DONATH and SPRUYT determined the vitamin B content of a large number of foodstuffs, including boiled milk, katjang bogor, and katjang idjo. A detailed investigation of the biological value of proteins and of the vitamin A, $B_1$, and $B_2$ content of fresh, boiled, salted, and dried fish was carried out by VAN VEEN. He also determined the $B_1$ content of a large number of important foodstuffs consumed by the population, the army, and prisoners. The assays were carried out on maize, sago, cassava, katjang idjo, katjang merah, katjang kedelee, etc. Their vitamin content was expressed in International Units, to facilitate the calculation of rations.

Finally JANSEN and DONATH succeeded in isolating vitamin $B_1$ in crystalline although, as was later shown, not chemically pure form. Their tests were confirmed by EIJKMAN. At first, the action of the crystalline preparation on beri-beri gave partially disappointing results; but later, far better results were obtained after VAN VEEN had succeeded in eliminating impurities from the crystalline vitamin $B_1$.

At last the arguments were closed. It was now proved that vitamin $B_1$, the value of which was first demonstrated in chicken polyneuritis, was also the important factor in cases of human beri-beri, a fact which until then had been assumed but not proved. In recognition of his fundamental work, which made the development of modern concepts of vitamins possible, EIJKMAN was awarded the Nobel Prize in 1929. He died in 1930.



# AN AMERICAN PLANT HUNTER IN THE NETHERLANDS INDIES

*by*

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## I. BUITENZORG AND DOCTOR TREUB (1895–96)*

On a beautiful spring morning I walked into the Hanbury Botanical Institute in Genoa. Its director, Professor Otto Penzig, was anxious for me to meet a young fellow named Rapps who worked in his laboratory, because Rapps expected to go out to Java in the near future. This young man had just come through a horrible experience. While on his honeymoon, he and his bride had stayed in a hotel lighted by gas. It was Rapps' first experience with illuminating gas, and he had blown out the light. His poor bride was asphyxiated and he himself barely escaped death. I mention this as partial explanation of certain incidents which occurred when he reached Buitenzorg.

The great day finally arrived and I sailed off for Java under Doctor Treub's chaperonage on a boat of the Netherlands-India Packet Boat Company.

That trip to Java in the nineties held more of interest than any ocean voyage I have ever taken. When I boarded the boat in Genoa and saw the turbaned Sundanese stewards, the Malays in their blue costumes, and the children's Javanese nurses, or "baboos," in their sarongs, I realized that I was entering a new world. By the time we reached Port Saïd, I had acquired a considerable acquaintance on the boat.

Entering the Red Sea was a great event. When I came on deck the first morning "east of Suez," the ladies lay in the chairs all along the deck clad in strange costumes or negligées — I was not sure which. They were nearly all barefooted and the sarongs which they wore were much shorter than the dresses of those days. I took a hasty look around and decided that I had mistaken the hour; that men were not supposed to be on deck so early. Turning abruptly, I fled from what seemed a definitely boudoir atmosphere. But Treub reassured me, explaining that the women had all donned native Javanese costume simultaneously because it was a fixed rule of the Captain that no lady could appear in native dress west of Suez.

From hot Aden, we sailed directly across the Indian Ocean to the west coast of Sumatra, an island which I believe holds more tropical beauty and mystery than any other spot in the world. The bewildering romance of the arrival in Padang and my first evening among bamboos, palms, and the noisy night insects, comes back to me often. I do not understand how any one can be content until he has experienced the wonder of the tropics.

Round-the-world tourists of today who find the streets of Batavia noisy with motor traffic, policemen and buses, can have no conception of the sleepy atmosphere which characterized that old Dutch town in the nineties. Its great open square, the Konings Plein, was surrounded by enormous *Ficus* trees and, in their shade, turbaned Javanese wandered barefoot, swinging their beautiful bamboo hats, or carrying on their shoulders long bamboo poles with baskets at each end. Tiny ponies trotted along, pulling some white-clad official sitting back to back with

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the driver in one of the two-wheeled carts called dos-à-dos.

In the hotel patio, the glare of midday was tempered by the shade of gigantic, overarching banyans, and an idyllic leisureliness pervaded everything everywhere. The "boys," in beautiful, handmade sarongs of brown and indigo, came and went noiselessly across the patio and along the verandah, speaking softly to each other in a language as musical as the speech of an Andalusian. Every afternoon after luncheon, a hush descended during the siesta hour. We drowsed happily, listening to the chatter of small parrots in the branches of the trees and the occasional thud of a coconut as it fell to the ground.

The delightful village of Buitenzorg, where I spent eight months, lies in the saddle between two smoking volcanoes, the Salak and the Gedeh. A little railway train, manned by turbaned natives, took me there. Joyfully tooting its toy whistle, the train crossed the lowlands and wound up the mountainside through the most fairylike and utterly delightful scenery. The swampy plain was filled with giant ferns and *Nipa* palms, those stemless Oriental palms whose fronds resemble giant cycad leaves. A strange mist hangs over these lowlands, making it an unhealthy place to live.

Soon the hills were reached, with their kampongs composed of pretty, little bamboo houses thatched with palm leaves and shaded by lofty clumps of feathery bamboo gently waving in the breeze. Clean-swept pathways led to the springs or brooks, where naked children and their mothers were taking a morning bath. Surrounding every bamboo house was a bamboo woven hedge, each one a different pattern. Hanging in little bamboo baskets from bamboo poles were cooing doves, the favorite song birds of the Javanese. It seemed a civilization dependent upon bamboo for both necessities and luxuries.

Before noon, I was installed at the one-story Hotel Chemin de Fer in Buitenzorg, and here I lived during the eight months of my sojourn. When I opened the simple wooden shutters of my room, I looked out on a thoroughfare crowded with traffic, but yet a noiseless one. For although a human being passed my window almost every second throughout the day, he passed silently, barefooted.

My broad, hard bed was spotless, and on it lay one of those curious, long, round cushions with which the sleeper is supposed to separate his knees at night for coolness. Festooned above the bed, on a metal frame, was a mosquito net, another object which I had never seen before. Although this was in the days when few men besides ROSS and THEOBOLD SMITH had an idea that the mosquito could be anything but a nuisance, yet there was an undefined suspicion that the miasma — the intangible something in the air which produced malaria — was kept out at night by the meshes of a mosquito netting.

Director TREUB kindly insisted upon accompanying me when I made my first visit to the Gardens. I must have delighted him with my astonishment when he showed me the great avenue of huge Canarium trees (*Canarium commune*, Java Almond) which are so dramatically tropical with their weirdly buttressed roots. The trunk and limbs of the great trees were festooned with variegated climbing aroids (*Pothos aureus* and others) over which the liana, *Entada scandens*, had climbed like some gigantic reptile. At that time, this was undoubtedly the most remarkable avenue of trees in all the world.

Doctor TREUB next showed me an orchid with a thousand blossoms (*Grammatophyllum speciosum*), and then took me to a tree from Africa which bore clusters of gold-edged, scarlet flowers. They were the great, flaming, cup-shaped blossoms of the African Tulip tree (*Spathodea campanulata*). As he picked up a fallen flower, he explained that, while in the bud, the gorgeous, red corolla had been held in its envelope of sepals by tough leathery bracts which contained a watery fluid under pressure. He had seen birds peck at these buds and had watched the fluid squirt from them. He thought the birds were frightened by the squirting fluid.

I was so entranced by the *Spathodea* that it was the first flower which I photographed. Today this tree has been imported and is growing casually in Florida, so perhaps I do not quite appreciate its rarity and beauty as I did then.

Director TREUB next took me into the tangled jungle of the rattan Palms. I brushed against a swaying tip and instantly felt its grip upon my shoulder. TREUB stood smiling at me as I struggled to free myself. The strength and sharpness of the clawlike spines was in surprising contrast to the delicacy and harmless appearance of the leaf tip. This tip is a climbing organ, quite as delicate as the tendril of the cucumber and other such vines.

The Director led me to the little laboratory which was placed at the disposal of visiting scientists. It was a great moment when I sat at the table designated as mine and realized that I had come to stay.

Everybody had a "boy," so TREUB turned his own boy, MARIO, over to me. I had never had a servant of my own, and felt myself a prince. Incidentally, I have never had a servant since who cared for me as MARIO did. From mounting microtome sections on microscopic slides to managing a caravan across the mountains, he took care of everything. I shall never forget his tears as I bade him a last farewell when I left the island.

As I learned a little Malay, I was astonished when chatting with the Javanese, Sundanese, and Madurese working in the garden to realize their knowledge of the plants. TREUB had recently decorated Mantri OEDAM, the Javanese head gardener, with the "Silver Star of Merit." OEDAM was a really remarkable botanist in many ways, familiar with every plant in the garden, and knew not only its native name but its botanical name as well. He had that rare faculty of form memory.

Everything was new and fascinating. If I had not been absorbed in my resolution to discover whether the ants and termites of the Orient were mushroom growers, I should have been distracted and probably would have done little of anything because of the wealth of novelty about me.

Each morning I rose early, as one does in the tropics, and MARIO would serve me with coffee. He would then run out in the street to secure a tiny dos-à-dos, and climb up in front with the driver to accompany me in the cool air of sunrise to the shady recesses of the marvellous botanical garden.

One of the wonders of the tropics is the Talipot

palm (*Corypha umbraculifera*) in bloom, as it so vividly exemplifies the strange forces which move in the plant world. In the early sunlight, I stood one morning watching clouds of the small, white flowers drifting down from the enormous flower cluster fifty feet above me in the crown of the immense palm. The ground was white with blossoms, and myriads of bees were busily gathering honey. This was the closing scene in the life of this palm. Like the Century Plant, it blooms but once and dies. The creamy inflorescence weighed a ton or more, and the palm trunk supporting it was two feet in diameter.

I was not a systematic botanist, and did not perhaps fully appreciate the wealth of species which had been gathered in this Garden from the vast archipelago which stretched away across the Java Sea to that mysterious, unexplored island of New Guinea two thousand miles away.

Those were days when much attention was being paid to adaptations of all kinds of plants to climate. GOTTLIEB HABERLANDT had just described the leaf pores which enabled plants to evaporate their moisture in the saturated atmosphere of such a place as Buitenzorg where there is over three hundred inches of rainfall annually. Hydathodes, these pores are called. Many intricate contrivances to insure cross-fertilization by birds and bees and other insects were also first described about this time.

One morning, across the street from my window, I heard the rustle of dead leaves in the native schoolyard. A giant *Ficus* tree had begun to drop its leaves, and a Javanese coolie was raking them up. Every day he raked them into windrows and burned them. It made me homesick for autumn days at home. But in Java the moment a leaf fell, a new one pushed forth in its place, and in another week the tree was in full leaf again.

TREUB believed that tropical trees which drop their leaves had gradually worked their way northward into the temperate zone because they had at least a brief dormant period, and while dormant could stand more cold.

The Botanic Garden was full of termites. After the first bewilderment of sight-seeing, I began to search for termite nests with the help of Papa IIDAN, the Javanese who collected material for the scientific men working at the Garden. Papa IIDAN knew these insects well, for they were at work around him everywhere. Their narrow trails of mud could be found on almost every tree in the Garden and on every wooden building, too. Once a runway was broken, out swarmed the termites by the thousands.

The termites resemble ants, although they belong to quite a different order of insects, (*Isoptera*), an order of straight-bodied creatures without the waistline of the ordinary ant. As a matter of fact, the ants are the natural enemies of the termites, and to defend themselves against the ants the termites have armies of soldiers. It was easy to tell the soldiers from the workers by their longish heads and the long pincer-like jaws which they were continually snapping. The soldiers were exceedingly vicious and would bury their pincers in one's finger and hold on with bulldog tenacity. Curiously enough, the soldiers were all blind, as were the workers, but the workers' heads were smaller than those of the soldiers, and their jaws, though inconspicuous, were marvellously equipped with teeth devised for sawing wood. Both workers and soldiers had long antennæ, resembling strings of tiny beads, which they waved continuously in the air.

It would take me too far afield to discuss the rôle these insects play in the economy of nature. There is perhaps no single factor more important in the complicated phenomena of the tropical forest than the termite. Every fallen tree, every dead branch or twig, almost everything made of wood, is quickly reduced to a pulp by the mouth-parts of the worker termites and passed through their digestive tracts with incredible speed. Another amazing thing about these insects is the fact that, apparently in order to digest these chewed-up fragments of wood, the digestive tract of the termite is inhabited by species of microscopic protozoans.

There is probably no more extraordinary example of architectural ability shown by any of the lower animals than that exhibited by the termites all over the world. Each species builds a distinct type of nest. In Java, termite nests, or mounds, were to be found here and there throughout the Garden and were abundant near the kampongs in the neighborhood. Before a week had passed, Papa IIDAN and I had opened up many of these nests and I became engrossed in studying one of the most fascinating groups of living organisms which inhabit the world.

Almost the first mound that we uncovered contained what I at once felt must be a mushroom garden. However, it took me six months of constant work to prove beyond the shadow of a doubt that I was right, and since then other scientists have proved it even more conclusively.

A termite nest is a dwelling, a fortress, and a truck garden. Built into the complicated, mud runways of the nest itself, are the gardens in which the termites grow mushrooms to feed their young. Each species of mushroom-growing termite apparently develops a different form of garden. Like our own mushroom gardens, these are composed of dung. But the termites make their fungus gardens with an art and skill in striking contrast to our gloomy mushroom cellars. Theirs are fragile, delicate affairs, honeycombed with myriads of passageways. These pathways through the mushroom garden are separated from each other by thin partitions composed of countless millions of individual deposits of excreta worked into position by the termite workers. This material is made up of fragments of digested, dead wood which that individual has probably gathered from some decaying forest tree hundreds of yards away. On this deposit grow the mushrooms.

Travelling back and forth through the long galleries or tunnels of mud which the colony is continually constructing, the swift workers are able to secure their daily meals of dead wood from an ever-widening section of the forest without going "out-of-doors," always progressing under cover from the sunlight in their mud tunnels. Being soft-bodied insects, they do not relish the sunshine or even the outer air unless the humidity is close to saturation.

There was something utterly fascinating about these gardens built within the termite strongholds. Their interior walls were covered throughout by pearly-white filaments of fungus, which lined the passageways as though with white velvet.

I always believed that these fungus filaments were deliberately maintained a uniform length, perhaps sheared off by the saw-like jaws of the

workers, just as humans keep the grass cut on their lawns. Here and there on the white velvet covering of the mushroom gardens, glistening white bodies, about half the size of the head of a pin, rose on short stems.

It was a great day when I held the first fungus garden in my hand and knew that I had been right in believing that the termites were mushroom-growers, and probably mushroom-eaters. I experienced the excitement which accompanies any real discovery, great or small. But how was I to prove the use to which these creatures put their fungus gardens? The instant a ray of light penetrated the darkness of the mushroom garden, every creature scuttled out of sight, or froze to immobility.

If you see a rabbit in a lettuce bed, you are pretty sure that he is there to eat the lettuce. But, if nobody has seen him eat it, you would be obliged either to watch him until you did see him munching the leaves, or to kill him, cut him open, and identify lettuce leaves in his stomach.

I tried my best to surprise the young termites actually feeding, but I could not get my microscope in place quickly enough. So I took the other method. I killed and dehydrated a number of the young, and embedded them in paraffin. I then sectioned them with my microtome and, by means of Doctor PAUL MAYER's stains, I identified the presence in their stomachs of the sporelike bodies which composed the pearly masses of the fungus gardens. Of course, this was to be expected, for why would these creatures build and tend such complicated gardens and grow such luscious, little, white cabbages if they were not to be eaten? But just the same it was necessary to prove it.

After making this discovery I ransacked the countryside to see if there were other species of termites, and whether or not they cultivated different species of mushrooms. I found that there were at least two other species of termites which made their own peculiar fungus gardens, both strikingly different from the one I had first studied, which was about nine inches across, and resembled a birthday cake with horizontal galleries. On the other hand, the other species of termites built gardens with the galleries running perpendicularly. Many of these would be scattered in a group under a mound of clay. Sometimes two forms of gardens would be together in the same termite mound. Once I found a tiny garden no larger than a tennis ball. It was very delicate and had been built by an extremely small species of termite about one-tenth the size of the other two species.

These termite species lived side by side, apparently in peace until I broke open the nests and disturbed them. Then they attacked one another and fought to the death. I used to put the soldiers of the different species two by two under a watch crystal and study them as they killed each other. A curious feature of these combats was that, as I have said, the soldier termites were quite blind. They used to wander furiously around the arena of the watch-glass, snapping their pincer-like, sharp-edged jaws viciously while waving their antennæ in the air. When the antagonists met it was usually near the rim of the watch-glass. The antennæ and legs would begin to fly, sheared off by the snapping pincers. Invariably one of the soldiers was left dead in the arena and the other crippled.

It is only when a termite leaves his legitimate field of devouring the decaying forest trees and converting them into mould, and turns his attention to the timbers which man uses in his dwelling, that he becomes a really important and dangerous pest.

The characteristics of the termites themselves became a part of my study of their gardens. One day, while sitting on the verandah of the hotel, a swarm of fluttering, winged insects filled the air. They were termites. The Malay "boys" arrived with brooms and pails and swept up the insects by the bucketful as they landed on the floor. Thus ended the last phase of what had been a marriage flight. I watched the winged insects chasing each other along the wall two by two. With a curious jerk of their shoulders, they broke off their wings of flight and, soon after mating, each couple prepared to begin a new termite colony by digging a hole somewhere in the ground. That creatures which have once had wings should throw them off deliberately and begin a subterranean existence, seems amazing.

Next morning I sent Papa IIDAN out to search for the queen and king of my termite colony; "the Rajah," he called the king. He soon brought me a piece of dark brown clay, thicker and slightly larger than my hand and with numerous little runways leading into it. It was so hard that I had to break it with a hammer. Inside, lying side by side in a royal chamber, were the queen and king. The chamber was low and broad, and the exits from it were only large enough to let the workers and soldiers pass. So enormous and "different" were the king and queen, that it was hard to believe that they had any relation to the other termites. The king was twenty times as large as any soldier, and had great facet eyes on each side of his head, in contrast to the eyeless workers and soldiers. The queen was an enormous creature, quite as large as my thumb and something the same shape. Like the king, her head had facet eyes. The pair lay helpless in this royal chamber. With my microscope I saw that, to all appearances, their legs had been chewed off; at least they were quite inadequate for locomotion.

It seemed fantastic that this strange queen, a thousand times the size of any worker, with her great, puffy, caterpillar-like white body, could be the mother of the myriads of soldiers, workers and possibly individuals of other castes which made up the termite colony.

I took the pains to dissect her carefully (later I even embedded another queen in paraffin and sectioned her) and found the soft mass which composed her body was almost entirely made up of eggs. Like strings of graduated beads, smaller at the top and growing large at the base, the eggs filled the entire cavity of her body. She was the egg-laying apparatus of this social organism, this collectivity, the group of busy individuals which made up the colony.

One day I timed another queen as she laid egg after egg. She averaged an egg a second — over 80,000 eggs per day. It is said that such a queen can live ten years. If she continued at this rate, she would be laying thirty million eggs a year. During this time, her consort would furnish the sperms with which certain of those eggs would be fertilized, and from them would develop the nymphs which composed a marriage flight such as I had seen that evening in the hotel.

It was with a certain sense of guilt that I spent

my days — many hours flat on the ground — beside the termite nests in the Garden and racked my brains devising means by which I might see the workers feeding the queen and king. But I believed that I was discovering something new, and the termites fascinated me completely.

Recently, my friend, MORTON WHEELER, published a delightful satire on human society entitled, "Foibles of Insects and Men." In it he described the termite method of practically eliminating the male from the social order, at least reducing him to a single male for the whole colony. WHEELER's charming paper was wonderfully understanding, and served to lessen my feeling of guilt that I had played with the termites instead of mastering the relationships of the hundreds of trees which had been collected in Java. Anyway, Entomology, Botany, and Horticulture are as inseparable in their interests as the Three Musketeers . . .

One morning, Papa IIDAN brought the branch from a guava bush into the laboratory. There seemed nothing unusual about it, but he pointed to an amazing leaf insect nearly three inches long belonging to the family of *Phasmidæ*. It exactly matched the under side of the guava leaf, and even had little spots which looked for all the world like "leaf spots" produced by microscopic fungi. The creature crouched against the leaf and moved only when I touched it.

Life in the delightful laboratory was equalled in interest by life in the hotel. After a fatiguing morning in the Garden, I used to swing off the step of the dos-à-dos just in time for the "rijsttafel" at the long hotel table. At this amazing meal we piled our deep plates high with steaming rice, and, as the long line of turbaned waiters offered them, added in turn a bit of fried chicken, slices of egg, perhaps a sardine, a meat-ball, or a fried banana. Then came the sambalang, — a great tray containing red Macassar fish, tiny pickled ears of corn, burnt peanuts, roasted coconut, sweet mango chutney, a darker brand of Indian chutney as hot as liquid fire, a peculiarly flavored pickle made from *Gnetum* (a strange climbing shrub), and others which I cannot now recall. After making our choice, we poured over the heaping mass a quantity of curry sauce made fresh each day from ground-up cardamons and fiery-hot red peppers. The first mouthful of this mixture brought the perspiration to one's face and started something, whether it was digestion or not I do not know. However, in the end, one experienced a sense of well-being and drowsiness which admirably suited the tropical custom of a siesta after luncheon, and the hotel became as quiet as the grave from two to four.

It was after one of these enforced siestas, which I at first detested, that I saw my first mangosteen (*Garcinia mangostana*). A coolie passed through the patio balancing on his shoulder two baskets hung from a bamboo pole. Seeing me, he held out a bunch of mangosteens, some dozen or more fruits tied together artistically by shreds of bamboo.

Resembling an apple of deep brownish-purple tint, mangosteens have short stems and four thick, leaflike bracts which form a rosette holding the purple fruit. The flower-end of the fruit is marked by the persistent stigma composed of seven triangular segments slightly raised above the surface.

Mangosteens have a tough, firm shell, and I had trouble breaking it open with my hands. The coolie showed me how to cut through the hard rind with my penknife and lift off the top as one would lift the cover from a sugar bowl. There, lying loosely in a pink cup, were five ivory-white segments glistening with moisture. They could be taken from their shell as easily as bonbons from a dish. Many of the segments are seedless, and the seed itself, which is also edible when cooked, is thin, brown, smooth, and flat. The meat has the consistency of a green-gage plum but a flavor which is indescribably delicious. Like many tropical fruits, there is a sprightliness of flavor, a suggestion of the pineapple, the apricot, the orange.

Of course, I immediately wanted to see this fruit on the American market, but there were many difficulties to be overcome. Java in those days was almost as distant as the moon. During the nineties, I made several attempts to get living seeds to the United States, — even coating some with paraffin, although the best method proved to be packing them in dry charcoal.

The first serious efforts of the Office of Plant Introduction were made in 1900. We soon found that the mangosteen was too tender to grow without protection even in southern Florida, and, consequently, included in our scheme the introduction of closely related relatives of the mangosteen, hoping to find hardier stocks. *Garcinia tinctoria* proved the best "relative" which was experimented with; *Garcinia binucao* from the Philippines seemed unusually hardy in South Florida and should be further tested as a stock. In fact there are many interesting, fine fruited strains of *Garcinia* which deserve to be studied.

We made repeated attempts to secure two species of *Garcinia* which are native to regions subject to frost, and were finally successful in growing *Garcinia mestoni* from Queensland. The other species is *G. multiflora* from near Kiaying Chow.

From our experiments we soon discovered that there are definite problems to be met during the early stages of a mangosteen's existence. Not only is the vitality of the seeds extremely low, but the young plants have a very weak root system and are easily checked in growth. An ingenious method was devised to resuscitate dying seedlings by inarching them on to a vigorous, rooted seedling of some other species of *Garcinia*. This seemed to revive the young, dying mangosteens much as blood infusions are able to save the lives of human beings. There may be more than an analogy here.

Today there is a healthy orchard of mangosteens at the Summit Experiment Garden in Panama. But we did not manage to establish this until 1923, after an ignominious defeat at the hands of the military régime in Panama when we made a first attempt in 1905, as I shall relate.

Doctor TREUB told me that he preferred another Javanese fruit, the pulassan, and I must confess that it does run the mangosteen a close second. The pulassan and the rambutan are two tropical relatives of the famous litchi of South China, and are all delicious fruits which were quite unknown in the Western Hemisphere in the nineties.

The fruit of the pulassan (*Nephelium mutabile*) is the size of a plum, and has a deep pink, pebbly surface, and a fairly thick skin. The single seed, with its surrounding pulp, comes out of

the shell like a grape, although it is drier.

The rambutan (*Nephelium lappaceum*) is much like the pulassan but is covered with soft, curled, tentacle-like hairs which make it somewhat resemble a chestnut bur. Unfortunately, both of these fruits proved too tender for Florida. The litchi (*Nephelium litchi*), which resembles the pulassan in appearance, is hardier and has been successfully grown in Florida.

I did not ask the coolie why he had no durians, for I had already heard that none were allowed in the hotel. The curious odor of a ripe durian (*Durio zibethinus*) is something which few Europeans can endure. However, ALFRED RUSSEL WALLACE declared that it was worth a trip to the East Indies just to taste a durian. Others, too, have told me of their passion for this fruit. To my shame I must confess that during my first stay in Java I could not bring myself to eat one. The prejudice of the people around me was so great, and the odor of rotting durians in the marketplace was so offensive, that to taste the fruit assumed the proportions of a major operation which I could not force myself to undergo.

When I returned to Buitenzorg later with Mr. LATHROP, I slipped away one Sunday afternoon to the native village, and tasted the custard-like pulp of a durian. Its flavor was indescribably rich and sweet, and I enjoyed it at the moment but, like other strongly flavored foods, such as raw onions for example, its odor returned to plague me.

I can still remember the expression on Mr. LATHROP's face when I reached the hotel that afternoon.

"Fairy!" he shouted, "You've been eating durian! I smell it! You get out of here and don't come near me until that stench has worn off."

In some respects, the durian is the most remarkable fruit in the world. The head-hunters of Borneo will commit murder to possess it. The fruits weigh from five to ten pounds and are about the size of a small coconut, completely covered with sharp prickles. The species most commonly cultivated is borne on a tall forest tree. Because of the weight and thorny surface of the fruit, it is dangerous to walk under a durian tree when the fruits are ripening. The seeds may be roasted and eaten like chestnuts. I have heard that the Chinese obtain an oil from the fruits which they use for washing purposes.

All this, of course, I did not know that day as I watched the coolie pick up his baskets, bow, and trot away. By this time clouds were gathering over the Gedeh. Flashes of lightning shot through the dark mass which covered the mountaintop. Rapidly the sunlight faded. Thunder rolled, and we were in for the afternoon downpour which came daily about four o'clock. The deafening beat of falling water is as much a part of the tropics as the brilliant sun and waving palms.

As quickly as it came, the storm passed. The cool, refreshed world assumed a hue of greenish-gold in the evening sunlight — a light unlike any seen in northern latitudes. Soon it was night again in that land of brief twilight.

One afternoon, I heard a curious, ripping sound and glanced toward a tall coconut tree just in time to see one of the coolies dodge a falling leaf. It was amusing to realize that my idea of a leaf, built up by exclusive association with the temperate zone, was an utterly inadequate conception. Imagine the incredulity of a Kansas boy if you told him that he would ever run from a falling leaf!

One of the delights of Java had been making the acquaintance of the coconut. It was an exciting experience to drink the milk from the nuts. Visions of Robinson Crusoe always came to my mind. How little I dreamed that I would one day own a place in the United States with coconut palms on it where I could drink coconut milk every day!

It seems almost inexplicable now that it did not occur to me to busy myself introducing the coconut into America, but in those days there were no gardens or agencies in the United States equipped to handle tropical plants. In the entire tropical regions of South Florida, there were only a few homesteaders and a meager number of winter visitors who came merely for a brief stay at the few hotels.

Fortunately, the coconut came into Florida from the West Indies almost on its own, so to speak, and there are now many thousands growing along the east coast. Their rustling fronds glisten in the sunshine and add greatly to the beauty of our streets and homes...

My fellow boarders at the *Hotel Chemin de Fer* were a strange but fascinating lot. My next-door neighbor on one side drank innumerable "bittertjes" and pestered me with strange inquiries about the English language, which he thought he spoke quite well.

"I am to be to are to want to go to bed. That is it English?" he once said.

My neighbor on the other side was a Belgian botanist named CLAUTRIAU from ERRERA's laboratory in Brussels; a brilliant, emotional young man who wrote letters of forty pages in fine handwriting to his mother, and later, poor boy, died of a broken heart soon after his mother passed away.

DE MUNNICK, another hotel guest, had been a Dutch functionnaire. He was interested in schemes for utilizing the fibers of the Kapok or Silkcotton tree which were then allowed to go to waste. He complained bitterly that his countrymen invested their money in American railroad stocks, but had nothing for the development of the Dutch East Indies...

This small group was augmented one morning by the arrival of Herr RAPPS, the man I had met in Genoa who had blown out the gas and asphyxiated his bride. With his advent, our peaceful existence came to an end. DE MUNNICK soon confided to me that RAPPS' baggage consisted of two enormous cases of Marsala wine and innumerable white sailor-caps. It also transpired that he had come to collect, not plants, but reptiles for a brother in Berlin.

RAPPS sent word to the native quarter that he would buy live snakes and lizards, and swarms of natives appeared bearing all manner of creeping things. He soon had a dozen great, long lizards which he fastened to the legs of his sofa. When their activities kept him awake at night, he hung them out of the window, but this manœuvre was not successful, for they soon scratched the plaster off the walls and he had to cut them loose. The natives would catch them and sell them to him again the following morning. It was a mad performance from first to last.

RAPPS also bought every available species of snake. We warned him about the deadly uler blang which, like the coral snake in Florida, has a mimic, a snake so nearly like it that it takes an expert to tell them apart.

I went into his disorderly bedroom one afternoon and saw a uler blang in a big candy jar with a cigarette stub holding the stopper open to give it air. I told RAPPS that this was the poisonous snake, but he scoffed at me and said that he knew snakes, and this was the harmless mimic. Nevertheless

I took the precaution of tying down the stopper before I left that night and made him promise that he would test the snake the next day.

In the morning, therefore, RAPPS bought a young chicken. When I arrived, he had the snake tied loosely to a stanchion on the verandah and the chicken held in his bare hand as he presented the bird for the snake to strike at it. The snake most certainly would have struck RAPPS' knuckles had I not pulled him back and helped him to arrange a safer test. I put the chicken in a box, covered it with a screen, and then put the snake in too. In a few minutes the chicken was dead. Needless to say, RAPPS' reputation as a herpetologist sank rapidly to zero.

His behavior also went from bad to worse. He disgraced himself at TREUB's immaculate retreat in the mountains by killing a wild boar, dressing it in the laboratory, and trying to make salt pork of it in a leaky flour barrel.

Eventually RAPPS decided on an expedition to the little island of Nias off the coast of West Sumatra. After shipping his badly prepared specimens to his brother, he departed one day taking with him what was left of his Marsala. Somehow, somewhere, he completely disappeared on this expedition. He was not regretted, I fear, for Doctor TREUB never could understand why Doctor PENZIG sent out such a man.

Most of the conversation among TREUB and his associates concerned the problems of the Dutch East Indian planters. Those were the early days of rubber and Sumatra tobacco. Also, at that time, Java coffee culture was being superseded by plantations of the Assam tea. There was much talk about which type of rubber tree would win out as the future source of rubber. TREUB believed that the "parlor" rubber tree (*Ficus elastica*) which was native to the East Indies, would have a better chance than *Hevea brasiliensis* from the Amazon. However, the Hevea now constitutes practically all of the rubber plantations of the world.

Occasionally I would go to the Hotel Bellevue to see the sunset on the Salak. It brought back memories of the fascinating man to whom I owed the wonderful experience I was having. Mr. LATHROP had described this scene when we parted that moonlit night in Naples, and no wonder the picture lingered in his mind. The music of the bamboo flutes drifted up at twilight from the kampongs, while native men, women and children bathed in the swift stream below, with charming decorum and modesty. Rustling palms swayed above, and great, cloud-capped mountains raised their heads in the arches of the lovely rainbows which followed the afternoon rainstorms.

In the virgin forest on the slopes of the volcano Gedeh, TREUB had built a small laboratory where the air was cool and fresh. He suggested my going there to carry on some microscopical studies, and MARIO cheerfully packed my equipment into the Standard Oil tins which were universally used as containers. Loaded down with a hundred pounds of baggage on each end of a bamboo pole, the coolies trotted off over the pass while MARIO and I followed in a dos-à-dos.

The rice around Buitenzorg had been harvested, and the workers in the paddy fields were planting the next crop, wading knee-deep in the mud. The terraces extended up the mountainside almost to the summits of the hills. As we drove up the Pontjak Pass, the season seemed to change. The late summer landscape melted gradually into spring, and I saw demonstrated the relation between altitude and latitude. We were following the spring north, as tourists from Florida so often do when they leave mid-summer verdure in Miami in March and find the cherry blossoms just opening in Washington.

A delusion common in those days was the belief that high altitudes in tropical mountains resemble the temperate zone, and that almost any northern plants could be grown in the tropics if planted high enough. Similarly, it was supposed that the mountain plants of the tropics could be cultivated in temperate regions. Many years and many failures finally disproved this theory. Aside from certain forms, the mountain species of the tropics cannot be cultivated in the lowlands of the temperate zone. Moreover, few of the temperate species are ever happy in the mountains of the tropics.

I received my first impressions of a virgin, equatorial forest during the days I spent alone on the steep trails of the Gedeh. CLAUTRIAU joined me there to pursue the study of the digestive juices of the wild pitcher-plants, while I discovered some new and interesting forms of parasitic fungi. In spare moments, I proved that my beloved termites were higher in the social scale than ants. I had brought with me nests of different species of termites and put them beside nests of the same species living there in the mountains. To my amazement, individuals of the different nests did not fight each other, whereas it is well known that the members of an ordinary ant colony will at once fight the individuals of a neighboring colony. It would appear, therefore, that the ants are still in the tribal stage, whereas termites might be said to have a higher or racial organization.

I had often heard of the edible bird-nests which are so much used by the Chinese in soups, and enthusiastic when CLAUTRIAU proposed a visit to the caves in southern Java where the swifts live and build their nests. These birds are a genus allied to the European swift.

It was quite a trip to the caves, and then we had to descend far to reach the bottom. We crawled down on long, primitive, bamboo ladders and finally found ourselves walking on a soft mass of débris on the floor of the great caverns. We could hear the swirl of the swifts above us as they escaped through an opening higher up in the cliffs.

We think of a bird-nest as constructed of sticks or mud but, when I climbed up the rock wall and pulled off one of those edible nests, it was composed of a substance as soft as some forms of mushrooms and it was almost translucent. These nests are, in fact, made of the foamy saliva from the salivary glands of many species of swifts which inhabit the caves of numerous Oriental islands and the mainland of southeastern Asia as well. Their exploitation is a profitable industry, and the right to collect nests is sold for a good price.

The caves also shelter and support a host of insects, some of which I at once began to collect. However, when I found a huge centipede within a few inches of my head, my ardor cooled momentarily. Armed with some bamboo pincers which MARIO had made for me, I captured the creature, which had legs nearly two inches long and vicious-looking jaws. I also took some of the brownish, powdery material which covered the floor of the cave. When I examined it in Buitenzorg, it proved to be a writhing mass of tiny red mites! . . .

My first information about the new quinine industry came from a lanky Hollander who appeared on the verandah of our hotel one day and

settled beside me for a chat. He was a cinchona planter, one of the first to successfully grow the trees in Java, and he had built a factory to extract quinine from the bark.

Hitherto quinine had come largely from the wild cinchona trees of Ecuador, and, as is the case of all wild cultures, the supply of bark could not be relied upon. It varied with the season and the temper of the Indian bark gatherers. Seeds of the different species had been sent from Ecuador first to Jamaica and then to the Orient for trial. In the nineties, their culture was being attempted in British India, Ceylon, and the mountains of Java. Although it may have been some special climatic condition in western Java which was responsible for the success of cinchona culture there in contrast to the failure in other tropical regions, yet I am inclined to believe that it was the persistence of the Dutch planters, assisted by government investigators, which contributed to the success of the new venture.

The work of breeding the different species of cinchona and selecting the best strains was just beginning when Doctor J. P. LOTSY arrived in Buitenzorg to find out in what part of the bark the alkaloid quinine was located and how it varied in amount from month to month. I had known Doctor LOTSY in Baltimore and was much pleased when he invited me to visit him at the plantation where he was establishing a headquarters.

In a clearing in the primeval forest, the cinchona trees had been planted, and the government had built a tiny laboratory and dwelling house. Through the jungle ran crooked trails made by the small Java rhinoceros, an animal today exceedingly rare (if not extinct) in the island.

The great forest trees were laden with orchids. If any of them seemed especially interesting, in a few minutes the skilled woodsmen had the tree lying at my feet. Botanizing through the branches of a tree in a tropical forest is a fascinating experience. A wealth of beautiful forms are found among the many tiny orchids, ferns, lycopods, lichens and bromeliads. Numerous species of plants and animals live only in the aerial world of the tree-tops, neither growing on the ground nor descending to it. Like the aquatic flora and fauna of streams and lakes, they live their own peculiar existence . . .

## II. RAMBLES IN SUMATRA (1926)*

Here we were, five of us, in Sumatra. The roads were good, and we wanted to get into the country. The only way to do so was to buy a car, so we picked up a second-hand Buick with the emblem of a crouching tiger on it, picturesque badge of the Deli Auto Club. It was our faithful companion until months later we sold it in East Java.

Our letters entitled us to call on His Excellency, the Governor of Sumatra, and our American Consul, Mr. THIEL, arranged the interview. His Excellency had known Dr. TREUB, and of course knew the Minister of Colonies, my old acquaintance, Dr. KONINGSBERGER. He spoke with pride of the new health resort at Brastagi he was building up and with a business-like despatch brought into our horizon the Chief Forester of the Island, Mr. BRANDTS BUYS, with whom we were, as it turned out, to spend many interesting days in Atcheen, one of the lesser-known parts of this great island.

Mr. BRANDTS BUYS was contemplating a visit to his forest stations north from Medan and urged us to accompany him. As we sat in his office discussing the possibilities, he reeled off a string of names. We would go to Tandjoengpoera, thence to Pangkalanbrandan, from there by Koelasimpang, Langsar, Lhoseumawe to Bireuen and from Bireuen up into the mountains to Takengon and Laoet Tawar. At Takengon we would leave the auto and trek on foot and pony back two hundred miles or so through Kota Dah, Pang Mop, Simpangtiga, Kota Kenjaran and Blang Kedjeren to Koetoe Tjane and round up in Kabandjahe.

Mr. BRANDTS BUYS spoke English, as all educated Hollanders do. I speak some Dutch and could help him out occasionally, but none of us talked Atchenese, and I shall never forget the bewildering sensation of that string of place names. It is curious now as I look back, how they have since become a part of our lives, for we made the trip with him, at least some of us did, and we have seeds growing in Florida and Honduras and Cuba and Panama, with many of these unpronounceable looking names attached to them. Every one of these, strange to say, is spelled phonetically and a Hollander has no doubt in the world as to how to pronounce them. They are not like Newara Eliya, in Ceylon, which is pronounced in English as though it were spelled Nuralia.

In the interim before we started up the coast we had time to visit the Proef Station or Experiment Station of the great "A.V.R.O.S." (Algemeene Vereeniging Rubberplanters Oost Sumatra). This General Association of Rubber Planters on Sumatra's East Coast is one of the greatest companies now operating anywhere in the tropics. As we drove in the direction of the Station we passed a beautiful white stucco building in the suburbs of Medan. It was as attractive as an art museum, but as we were looking for an experiment station, we passed it and drove on, only to be turned around and sent back to it by the next man we asked directions from. When we entered the spacious hall and visited the beautifully equipped, spick-and-span laboratories, DORSETT and I looked at each other and wondered. We had seen beautiful experiment stations before, but one such as this had not even entered our imaginations. And here it was, on the very edge, so to speak, of the tropical jungles of an island about which it was difficult to learn anything in Ceylon, and in the suburbs of a town which thirty years ago was only a native kampong. It was a palace of research maintained by a great commercial company that was developing the resources of Sumatra. As we were shown the courtesies of the laboratories and met the young research men who were

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working on every sort of question connected with the rubber and other plants in which the A.V.R.O.S. is interested, I could not help rejoicing to see the evolution of the new and modern method for man's control of the vast resources of the tropics.

For countless generations those humans born within the borders of the tropics have been trying to cope with the jungle, and so far as one can judge, with mighty little success. Their houses, their tools, their sanitation and their intellectual lives have remained very close to savagery. The jungle has been so near to overwhelming them all the time; its weeds, its reptiles, its insects, its fungi which attack their cultivated plants, and its diseases which attack and kill or disable them, have all combined with a climate that stimulates indolence to hold tropical men back. White men by the hundreds of thousands have ventured singly into its shades, have cleared patches of land and planted their crops, only to leave their bones somewhere in the jungle. One could almost paraphrase BYRON's saying "Man's control stops with the shore" and apply it to the jungle rather than to the sea. Man has now organized in great groups, in industrial armies as it were, and today is conquering the jungle so fast that those of us who love its mysteries and its wild life tremble lest these armies destroy it completely. This Proef Station with its bacteriologists and chemists and entomologists, represents part of the great fighting machine with which this industrial army is combating its tropical enemies.

There is another point of view also from which such gigantic associations of capital as that represented by the A.V.R.O.S. is interesting. Among the growing army of scientific discoverers throughout the industrial, chemical and medical world an individual may arise at any time with a new idea, which, like the idea of GOODYEAR, may make necessary to the civilization of the great temperate regions some as yet unsuspected resource of the jungle, some tree perhaps, known now only in the dry tomes of a systematic flora. The A.V.R.O.S. forms the link between the new discovery and the plantations of raw material required to put it into action.

There is something quite American, I find, about the Hollander as you meet him in his colonies. He is casual, sincere, and hospitable. Dr. DE JONG and his assistants were amused, I presume, by my quest for the relatives of the mangosteen but they showed me all they had, and there for the first time I saw the "Assam Geloegoer" (*Garcinia atroviridis*), used, like the "Goraka" of Ceylon (*Garcinia cambogia*) in curries. Its rind splits naturally into segments on ripening, and these, when dried in the sun, turn black and keep for weeks, retaining their incredible sourness to the end.

I had not come to Sumatra to study the rubber situation. If I had been going to study it I should have done so when I first visited Singapore in 1896, at which time Dr. RIDLEY showed me the trees on which he was working out the modern method of tapping. But who could have guessed then that America would ever have any tropical territory or that she would develop a sense of the importance of the tropics. Our manufacturers were getting the little rubber they needed from up the Amazon and there was not a single American who would have listened five minutes to any talk I might have given him about plantation rubber in the Orient.

However, when the geneticist, Dr. HEUSSER, showed me some of his grafted or budded rubber trees and told me that as much as fifty grams of rubber had been taken from a budded tree only seven years old, whereas the average of the seedling trees in the plantations was only seven grams, I could understand what a chance there may be in the substitution of budded trees for seedlings. Later on, near Langsar, I saw one of the more progressive estates, and was shown a small commercial planting of budded trees. While every experience of the orchardist would seem to point to the advantage of growing trees budded with wood from record latex bearers rather than the hit-or-miss seedlings of unknown ancestry, there appear to be a good many points still to settle before extensive plantations of budded rubber trees become a factor in the rubber situation. That the industry is pointed in this direction seems certain.[1]

Sumatra seems to be the rubber growers' paradise. I judge this from the comparisons which one of the progressive planters drew between the labor conditions there, and those in Java and the Malay States. The Sumatra planter contracts with the Government for his labor, guaranteeing certain comforts. In return he is insured against certain defections on the part of the laborers, most of whom he brings from Java. He does not have to deal with any labor organization or with any native chief in the employment or dismissal of his laborers, as the planters in Java and the Malay Peninsula must do. The supply of Javanese labor is the greatest factor in the rubber situation in the Orient, it would seem. When one compares the systematic agricultural habits and the teachability of the Javanese, with the characteristics of almost any other race which today is tapping rubber, I do not see how one can fail to appreciate the advantage they bring. The tapping of rubber is almost a carpenter's job. It requires a steady, trained hand to push the flat gouge along the upper edge of the thick bark and pare off a thin shaving from it without either cutting into the tender growing layer of cells, or cambium, or leaving some of the bark by cutting too far from it. To do one or the other brings burylls or knots that interfere with the tapping years later. In Sumatra there is a system of penalties and bonuses depending upon the amount or lack of these injuries, and an inspector checks up the work of the tappers and keeps a record of each one's work. The plantation I visited had 2400 acres, and was operated by nine Europeans who managed the machinery and the 800 Javanese tappers and collectors, many of them women. The highest pay of the tappers amounts to about $7.00 a month, without food supply, and a good tapper will tap 400 trees a day and do it in four hours of continuous work.

I shall not forget the sensations this trip through the large plantation near Langsar gave me. Man had, in my lifetime, substituted a forest from the Amazon for a primeval Sumatran forest, and had done it so hurriedly that there, among the straight rows of large Brazilian rubber trees the giant blackened stumps of the original Sumatra trees were still standing. I was reminded of an evening in my own home in Wash-

[1] I learned more about the budded rubber later from Dr. CRAMER in Buitenzorg, to whom is accorded the honor of first budding rubber trees on any considerable scale. . .

ington, when Dr. HUBER of Para told me of his trip for the Brazilian government, to see what plantation rubber in the Orient was likely to do to the Brazil rubber industry. "Brazil can never compete with the Orient, we haven't the labor," was the way he put it.

There is another Experiment Station in Medan, that of the Tobacco Planters of Deli. I wanted particularly to see this, for it was the first of the private experiment stations that Dr. TREUB had just succeeded in getting started in 1896 when I landed with him in Java. It was his newest toy then, and BREDA DE HAAN was its first director. I could not but recollect those early discussions around the dinner table in Java as Dr. PALM, the present director, told me of the widespread distribution of mosaic diseases in the tropics, diseases, the very existence of which was not suspected in those days. As an indication of the change that has come since the nineties, it is interesting to know that over a million dollars a year is spent by the private tropical plant experiment stations in the Dutch East Indies.

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At last our camp equipment was ready for the trip with Mr. BRANDTS BUYS, and the cars were loaded with bed rolls in oilcloth covers, and tin cans full of clothing and supplies of all sorts. Tins full of alcohol, tins full of photographic films, tins full of food, everything in tins to protect them from the tropical downpours. To dry plants between sheets of paper is an easy matter in dry regions. MAIRE in Morocco, for example, used newspapers, and every night used to strew his half-dried specimens all around his bedroom and the next morning gather them together again into his wire press. Such a method, however, does not work in the dripping rain forests of Sumatra where all day long the relative humidity stands around 90% and in the morning may be as high as 99%. The speed with which a plant molds there is amazing. To prevent this the newest technique is to lay the specimens between the driers, and when a large package has been made slip it into a tin case, pour some alcohol into the case and seal it up. A pint of alcohol in a five-gallon can will keep the plants from decay for a very long time. The drying process can later be completed by artificial means.

There were so many tin cans (altogether too many, DORSETT maintained, and I believe he was right) that GRAHAM and DORSETT had to travel part way by train. I wanted to see the vegetation fringing the coast of Sumatra and compare it with that of South Florida. I have always wondered if certain Asiatic species composing the coastal swamp vegetation of Asia might not be introduced into the American mangrove swamps that have come to play such a part in the beauties of southern Florida.

The day was hot, but the roads were good and soon we were traveling north through the low country near the coast, bound for Takengon. If one does not mind the heat, the low country is by far the most interesting botanically, for there is where the strange palms, lianas, and dank tropical jungles are at their best. We passed through native pepper plantations, and, as I waded through the long grass to refresh my memory of this strange evergreen vine, hanging in tresses from the shade trees on which it is trained, I could not help thinking how strange it is that the tiny black fruits produced by this relatively uncommon vine should have found their way onto the tables of civilized man throughout the world, becoming the universal companion of salt, that essential mineral of our foods. Its appearance on man's table dates back far beyond Roman times and it is recorded that ATTILA the Hun demanded as part of the tributes in the sacking of Rome, 3000 pounds of black pepper.

Leaving the road we went by motorboat out into Aroe Bay where the mangrove vegetation with its long hanging fruits, ready to drop and float in the water, reminded us all of the coastal mangroves of Florida. Even the stories of crocodiles were not wanting. In the swift currents of the bay many fatalities have occurred that were to the advantage of these water demons. Sixteen natives were eaten by these brutes in a single eddy.

I was interested in the "Niri Boenga" (*Xylocarpus granatum*), claimed to be the best of the tidal swamp tanbark trees, but I cannot see any early chance of its being utilized. In order to add its interesting form to our own mangrove swamps I accepted Mr. BRANDTS BUYS offer of seeds for America. The two Asiatic *Rhizophoras* (*R. conjugata* and *R. mucronata*) were here mingled, neither species however, producing trees so stately as our own mangrove (*Rhizophora mangle*), and although their aerial roots are as remarkable, I am inclined to believe that so far as bizarre and fascinating forms are concerned, Florida can be proud of having some of the finest mangrove swamps in the world. May she long be able to keep them. They are making land for future realtors to sell, perhaps, but they furnish today one of the most unique plant sights in the world.

I have long hoped to see the Nipa palm (*Nipa fruticans*) growing on the shores of Biscayne Bay. It inhabits the low salt marshes of the Oriental tropics, where its masses of great erect leaves rising from the ground add much beauty to the coasts of this whole region. I once succeeded in getting some seeds of this palm started and Prof. CHAS. T. SIMPSON of Little River, Florida, even got one of them to grow in his hammock, but do what he could, he was not able to protect it from the crabs. It was exciting to see the nipa again and to arrange for another shipment of the heavy fruits, though a year later the failure of the shipment was announced.

Passing through a little village we all scented a delightful fragrance and found it came from the avenue trees lining the highway. They were covered with yellow blooms and the whole make-up of the tree seemed to fit it in a peculiar way for the making of a tropical avenue. It was *Pterocarpus indicus*, a leguminous species that deserves to be thoroughly tried out in South Florida as a shade and avenue tree. More seeds must be secured, however, as those we sent in failed to grow.

As we passed through a native market by the roadside and I got out to look at a strange fruit, which to this day I have not been able to identify, Mr. BRANDTS BUYS whispered to me that this was one of the places where they had had trouble with the natives, and a little further along the road where we stopped to change a tire, I noticed that he kept a sharp eye on some surly-looking fellows in a hut near by and he told me that he did not like their looks. Aside from these incidents the whole trip was through a seemingly friendly country.

The hotel at Langsar had been kept for many years by a man who took an interest in insects, and when he heard that GRAHAM was collecting them he told us that near the oil field of Darat, where one of the wells burned night and day he had seen the great Atlas moths so abundant that they formed great windrows on the ground under the lights, and that he had seen tigers from the forest feeding on them. We noted this locality on our map as one to visit, but were never able to do so.

I think the drive from Langsar to Lake Tawar deserves to rank as one of the great drives of the world. It skirts the lowlands for about one hundred miles and then climbs between mountains almost ten thousand feet high to the enchanting mountain lake, or "laoet," Tawar.

The lowlands were hot and it was afternoon before we reached Bireuen and began to climb. Roads in a tropical mountain region where hand labor is cheap and bridging material expensive are about the crookedest things in the world. They follow in and out every ravine or gully on the hillside. One's steering wheel is constantly turning, and turns too sharp to make without backing are frequent. The sun set and a brief twilight ensued, followed by a rising moon, as we climbed up onto the ridge, with tropical jungles stretching away on either side. As we dipped down into the deep shadows cast by the mountain, we heard a distinct roar from the forest. BRANDTS BUYS whispered to me, as though he thought the cry might alarm Mrs. FAIRCHILD, "It's a tiger." We were delighted and listened for the next scream. It was thrilling to be traveling by moonlight through a jungle infested with man-eating tigers. Two men and four bullocks had been dragged off this same road by a man-eating tiger the month before as they were driving bullock carts to Bireuen.

On a sharp high turn we stopped and got out. Going up into the forest a hundred yards to a little lookout, we saw before us Lake Tawar, shimmering in the moonlight below. Dark mysterious mountains surrounded this little lake in the jungle, a few white houses on its shore marked the village of Takengon. It was an enchanting tropical scene.

In a few minutes we pulled up before the passangrahan or Government owned resthouse at Takengon. DORSETT and GRAHAM were waiting for us at the door and the rijsttafel was ready in the kitchen. The rijstafel of Takengon, this tiny speck of a place in Atcheen seemed better, with more strange things in it, than had the finest Ceylon curry we had eaten in Kandy, but then the temperature had something to do with it, for the thermometer stood at 54° F., and we rubbed our hands to warm them.

Those mornings in Takengon; how shall I describe them? They held the quality of spring. The clear cool air and brilliant sunshine made one think of northern latitudes. The courtesy of a launch ride on Lake Tawar was extended to us and as the sun broke through the clouds in great streams of light we explored its shores. The lowlands were filled with paddy fields, the ravines were masses of tangled lianas, here and there gigantic clumps of bamboos waved their stems in the air and at one point a perfectly enormous mango tree stood all by itself in the landscape. The mountain slopes themselves were covered with pines, solid stands of the Merkus pine (*Pinus merkusii*) which Mr. BRANDTS BUYS wanted us to see. On one side of the lake we passed the cunningest dollhouse-like little dwellings on piles, seventy-five of them, summer "cottages" of the Gayo people where whole families come to spend a month and fish. At the season when the "Tepik" wind blows in August, shoals of small so-called Tepik fish frequent this shore and the people catch them by the millions from these houses on the water and dry them there to eat with their rice. One gets the impression that the Gayoes lead a pastoral and peaceful family life on the shores of this mountain lake.

There was a road halfway round the lake and we started out along it one afternoon, botanizing up into the pines, where DORSETT discovered a remarkable tropical raspberry with light red fruits and leaves that were golden brown beneath (*Rubus chrysophyllus*). This was a new collecting field and we were keyed up; we did not have any idea of what might be ahead of us. I happened to be alone for a moment on the trail when, looking up, I saw before me a gray cliff over which was festooned the loveliest evergreen climbing fig imaginable, with a hundred or more brilliant scarlet fruits set off by the glossy green of the foliage. The habit of the plant reminded me of the common *Ficus repens*, but the leaves were coarser and the fruits several times as large and the most striking scarlet color I have ever seen in any fruit. As I stood looking at it and wondering if the fruits were good to eat, and how we could get some of them, and how lovely a plant of it would be on the wall of a house in South Florida, I was conscious of experiencing in a measure the delights of those early explorers who first set eyes on the *Victoria regia* or the rafflesia or the jacaranda, let us say. The party came up and it was with some difficulty that JIM and GRAHAM scaled the cliff and brought down the fruits. They were as harsh and rough to the touch as a piece of sandpaper, and the foliage was harsh too. The superb-looking fruits were not good to eat. Alas, though we packed the ripest seeds we could get, in every way known to us, and posted them, as well as some cuttings, from Takengon by letter post, none of them reached America alive. So far as I know, it has not yet received its baptismal scientific name . . .

Mr. BRANDTS BUYS wanted us particularly to see the stands of Merkus pine, as he was working on the theory that vast forests of it could be developed in these Sumatra highlands, and since it is an excellent turpentine-producing species this would add great wealth to certain mountain regions of the Dutch East Indies where little that is of value is now grown. His first problem was to check the fires and stop the encroaching tall grasses which are the destroyers of the pine forests. These two agencies work together in an association more perfect than many of the "symbioses" of field botanists. Grasses alone cannot destroy the forest, but combined with fire they are destroying it everywhere. Let grasses start at the edge of the forest where they get enough sunlight, then if they catch fire in the dry season the trees on the edge of the forest will be burned, and into this fringe of dead leafless trees the grass spreads with the next wet season. Repeat this process for centuries and the lands capable of supporting the trees will become grasslands. Nowhere have I seen more striking demonstrations of this phenomenon than here in the

jungles of Atcheen. By grasses I do not mean the blue grass which the colored man cuts from your lawn every month. I mean grasses as high as your head, grasses that make so thick a carpet on the ground that seeds dropped from the trees cannot get through, grasses that you could grub out every week from the ground and that would grow again where you had thrown them to die. Grass is the curse of the tropics, as every planter will tell you. Shading it out with other plants seems to be the only method of combating it.

So we drove down the highway to Lampahan and struck through into the dense forest. The road became a mere trail, the vegetation became more dense on either side and the tree buttresses became larger. There are no giant trees such as the California sequoias and redwoods or the Australian eucalyptus to be found anywhere in the tropics; they do not exist there, but why this is so is one of the botanical puzzles. What seems to me the most striking difference between the tropical jungle and such a forest as the redwoods, for example, is the tangled character of the one and the simple open character of the other. In the redwood forests, as far as you can see, the trees are redwoods; the same type of tree meets your eye wherever you look. In a tropical forest you may have two hundred species of trees in a single acre, a bewildering arboretum if you please, with nothing labeled, and with the flowers a hundred feet above your head where the monkeys are playing.

We stopped under a strangler fig, which would serve as a landmark, and with our long knives in our hands scattered through the forest to do a little collecting. The undergrowth was dense, there were numberless climbers with recurved spines; every step of the way had to be hacked and it was surprising how quickly one got lost and how far away and faint the calls of the others became. Go into a corn field and notice how quickly you get into a silent world, and how soon you feel yourself alone. A strange distant sound like the bark of a dog, and yet different, reminded me that the native forester had reported meeting a tiger on the trail the day before.

Ahead of me stood a smallish tree with branches low enough to the ground so that I thought I could get specimens of its foliage and flowers if it were in bloom. To my surprise it was unmistakably a *Citrus* tree, but since there were no flowers or fruit the question of what species it was has remained in doubt. I am inclined to think it is a wild form which DORSETT later found in fruit.

As I hacked my way through the dense tangle of climbing ferns and grasses I happened to look down, and pushing the tangle aside with my long knife I found I was on the very brink of a deep gully and that the enormous green leaves below me were the tops of tall tree ferns growing up from its bottom. One winces a bit at such discoveries and can hardly help wondering how it would ever be possible for one's friends to find one should one fall into such a gully in a jungle which it takes days to cut through in a single straight line.

The turpentine still stood in a magnificent stand of the merkus pine some miles further on. It was a clearing in the forest like many I had been familiar with from childhood, for in place of the myriad species of trees we had been seeing in the jungle, here we were surrounded by the trees of only one. The turpentine tappers were at work. Mr. BRANDTS BUYS had designed their special tool and prescribed the method, which is the most refined of any turpentine tapping I ever saw. It stood out in strong contrast with the crude, inhumane methods of our own southern states, where a tool of the most primitive make is used, and where little attention is paid to the life of the trees. It suggested the rubber tapping technique, which has been the secret of the success of plantation rubber in Sumatra. Only a small thin chip is taken from the wound each day, and while I shall not go into a discussion of its superiority over the French or American methods, I cannot help reminding those who may be inclined to be skeptical, that the Dutch have made great successes of plantation cinchona, of plantation tobacco, and of plantation rubber, and are making great progress with their plantations of West African oil palm, manila hemp and gutta-percha. Plantation turpentine may yet come on the market.

We botanized another day, the whole party of us, from the highway, using the automobile as a base and spotting fruits and flowers in the forest near by. If anybody imagines this has any resemblance to botanizing from an automobile on the Great Plains, he must revise his notions, for the flowers on a level with our eyes were in tall trees that rose from the steep mountain side far below the highway. To hack one's way down to them took much time, great physical exertion and some risk; then, in order to clear the trunk of the tree so that it could be climbed, all kinds of spiny lianas, incomparably worse than any green briar or saw briar which grows among the sassafras trees of Maryland, had to be laboriously gotten out of the way.

Festooned from many of these forest trees hung climbing species of ficus with extremely decorative fruits, not so beautiful as the ones we had found on Lake Tawar, but still very attractive and certainly desiderata for South Florida. One of the most attractive of these JIM DORSETT had a hard climb to get. Anyone less determined and less agile would have given it up, so we photographed him holding it as he stood panting from his exertions in the sunlight. The fruits were not ripe, but we wrapped some cuttings with the greatest care and posted them, letter post from Takengon to Washington. They were propagated as F. P. I. 67559, *Ficus callicarpa*, in the tropical gardens of the late Dr. H. NEHRLING at Naples, Florida. Some day it will add its beauty to the tropical vegetation of that new commonwealth.

One morning while the others were busy with their preparations for the trek through the jungle, Mrs. FAIRCHILD and I motored with Mr. BRANDTS BUYS to a point on the trail where I had seen a relative of the chestnut, a *Castinopsis*, the seeds of which I thought I could easily get. With our klawongs we scrambled up the steep slippery slope into the jungle, and the undergrowth closed in around us. It was stiff hacking and going. Suddenly not a quarter of a mile away we heard the unmistakable snarl of a tiger. When that snarl breaks the uncanny stillness of the forest it startles anyone! It was pretty near, but not so near as we were to the road, so we kept on. Another snarl still nearer: evidently the beast was coming our way. Another and another, each louder than the last, and finally BRANDTS BUYS said that while ordinarily tigers stalk their prey stealthily and at night, a hun-

gry man-eater will roar around and even attack in daylight, and as this one was so evidently coming our way he thought we had better get out of the jungle. Mrs. FAIRCHILD most heartily agreed with him, so we withdrew, though not before I had satisfied myself that there were no ripe seeds on the tree. A few days later, Mrs. FAIRCHILD and I, thinking that our nerves had been in no way affected by this experience, which we had both keenly enjoyed, returned to this same highway about dusk and made our way across an open field up to the edge of the jungle. I started collecting while Mrs. FAIRCHILD got out her little alcohol lamp and started to brew a pot of tea. Suddenly there was a crash right behind us. I think both our hearts were in our mouths. A great branch, loosened by some storm had fallen, although there was not a breath of air moving, but the idea of camping out alone in the forest as we had often done elsewhere, lost its attractions.

* * *

We spent nearly a week in Takengon, all of us together, before things were in readiness for the more strenuous part of the trip, the two-hundred-and-fifty-mile trek through the forest, but at last the coolies had all been engaged, the live chickens bought, the apportionment of the loads for each had been made and everything was in readiness. Who was to go? Mrs. FAIRCHILD was only a few weeks out of the hospital and could not go, and I had been having a good deal of trouble with my feet, an old case of flat-foot. Some one familiar with the material we had already collected had to remain to attend to it or it would be lost. I was not willing that one of the next generation should be deprived of the experience and DORSETT did not drive the car, so it fell to my lot, so to speak, to be left behind. It was rather a bitter thing, but then the whole region was so full of interest that I soon forgot it.

We had not imagined that taking leave of the boys, where the road ended and the trail into the jungle began, would be any more exciting than watching a group of friends disappear on the rear of a Pullman train, but it was. The trek was about as far as from Washington to New York. It was to take ten days or two weeks and there was no way of getting word to them during this time. We were to motor back to Medan, get up again on the high tableland from there, and meet them at the other end of the trail. Just at the last minute, as if to add spice to the excitement, BRANDTS BUYS came to me with the news that not fifty miles from where the trail passed, some Atchenese had, a day or two before, ambushed a small guard of Dutch and Amboinese soldiers, massacring most of them, and as there were to be foreigners in the party the Governor had thought it wiser to send a guard of soldiers with the expedition.

It was quite a sight to see them start. Beside the chief forester there had been added to the expedition Mr. FERNANDES, the local forester, so that the party consisted of five white men, with three ponies for those who got tired of walking, and an imposing number of coolies and soldiers.

As Mrs. FAIRCHILD and I stood on a pile of logs and waved farewell to the men as they disappeared single file up the mountain side through a gap in the jungle, I felt we were experiencing the great and rather melancholy feeling my great grandparents must have known when they bid good-by to their sons and relatives bound from New England for the great forest area of the Western Reserve. At least the stage setting of the end of a forest trail was there, and the dangers, real or imaginary, were much the same.

With the let-down feeling that comes after seeing friends off, we motored back to the pas-sangrahan and went to work on the seeds and plant specimens. There is something exciting about packing up seeds you have gathered and in which you have great hopes. There is a keen pleasure in gloating over your herbarium specimens as they dry in the blotters; the data must be attached to them, and every morning they must be aired and the blotters changed or they will mold, and while Mrs. FAIRCHILD and I found the task of saving what we had gathered in the jungles no easy one, particularly when we got back to the steaming lowlands and found hundreds of specimens in peril, I think we both look back to the herbarium days in Sumatra with a good deal of sentiment.

The long black log dugouts of the Gayoes tied up to the little wharf looked very inviting and one day we took an oarsman and paddled across in one to the far side of this enchanting Lake Tawar. The dugout has none of the balance of a cayuka on the Chagres, but is more like a birch-bark canoe in its temperament. We got across all right and found ourselves among some of the most peculiar clump bamboos I had seen. Their rhizomes formed great mounds higher than one's head and from the tops of these irregular mounds rose the tall plume-like stems. There were two kinds, the "Bœloe Besar" and the "Bœloe kechil," the large and the small, in other words. It took me some time, even with the help of the Gayo boatman, to get rhizomes of these species for the post. One lot arrived dead, but the other was reported alive when it reached Washington.

I picked up a local native and he guided me up one of the ravines that led into the pine forest above us, Mrs. FAIRCHILD preferring to remain behind. It was a day that reminded me of Italy. We climbed on and on, my guide muttering something all the time that I could not understand. At last we came to a little clearing in which was a single pine, and under it a tiny thatched hut with a floor made of pebbles from the beach, evidently the grave of some holy man. I saw that my native guide was awed, and I realized that, standing side by side before it, he and I were looking into the same universal mystery and that our feelings were in no way widely different. All the heredity and environment which had been mine gave me no particular advantage over him when it came to the matter of death. He had wondered about it, so had I. He had not been able to solve it, neither had I. The chief difference between us lay in the amount of superstition we accepted. For him the world was full of spirits and ghosts; every accident of his life was due to the machinations of his imaginary world. For me the spirit world, in his sense, had been demolished. I had learned to explain the occurrences about me in another way, which, while not dispelling the mystery, had dispelled the superstition and fear. I have often thought of him, that Gayo guide.

He had a superbly fashioned klawong, mine was a poor cheap thing I had bought of a Chinaman in Takengon, and I think he pitied me. He

jungles of Atcheen. By grasses I do not mean the blue grass which the colored man cuts from your lawn every month. I mean grasses as high as your head, grasses that make so thick a carpet on the ground that seeds dropped from the trees cannot get through, grasses that you could grub out every week from the ground and that would grow again where you had thrown them to die. Grass is the curse of the tropics, as every planter will tell you. Shading it out with other plants seems to be the only method of combating it.

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As I hacked my way through the dense tangle of climbing ferns and grasses I happened to look down, and pushing the tangle aside with my long knife I found I was on the very brink of a deep gully and that the enormous green leaves below me were the tops of tall tree ferns growing up from its bottom. One winces a bit at such discoveries and can hardly help wondering how it would ever be possible for one's friends to find one should one fall into such a gully in a jungle which it takes days to cut through in a single straight line.

The turpentine still stood in a magnificent stand of the merkus pine some miles further on. It was a clearing in the forest like many I had been familiar with from childhood, for in place of the myriad species of trees we had been seeing in the jungle, here we were surrounded by the trees of only one. The turpentine tappers were at work. Mr. BRANDTS BUYS had designed their special tool and prescribed the method, which is the most refined of any turpentine tapping I ever saw. It stood out in strong contrast with the crude, inhumane methods of our own southern states, where a tool of the most primitive make is used, and where little attention is paid to the life of the trees. It suggested the rubber tapping technique, which has been the secret of the success of plantation rubber in Sumatra. Only a small thin chip is taken from the wound each day, and while I shall not go into a discussion of its superiority over the French or American methods, I cannot help reminding those who may be inclined to be skeptical, that the Dutch have made great successes of plantation cinchona, of plantation tobacco, and of plantation rubber, and are making great progress with their plantations of West African oil palm, manila hemp and gutta-percha. Plantation turpentine may yet come on the market.

We botanized another day, the whole party of us, from the highway, using the automobile as a base and spotting fruits and flowers in the forest near by. If anybody imagines this has any resemblance to botanizing from an automobile on the Great Plains, he must revise his notions, for the flowers on a level with our eyes were in tall trees that rose from the steep mountain side far below the highway. To hack one's way down to them took much time, great physical exertion and some risk; then, in order to clear the trunk of the tree so that it could be climbed, all kinds of spiny lianas, incomparably worse than any green briar or saw briar which grows among the sassafras trees of Maryland, had to be laboriously gotten out of the way.

Festooned from many of these forest trees hung climbing species of ficus with extremely decorative fruits, not so beautiful as the ones we had found on Lake Tawar, but still very attractive and certainly desiderata for South Florida. One of the most attractive of these JIM DORSETT had a hard climb to get. Anyone less determined and less agile would have given it up, so we photographed him holding it as he stood panting from his exertions in the sunlight. The fruits were not ripe, but we wrapped some cuttings with the greatest care and posted them, letter post from Takengon to Washington. They were propagated as F. P. I. 67559, *Ficus callicarpa*, in the tropical gardens of the late Dr. H. NEHRLING at Naples, Florida. Some day it will add its beauty to the tropical vegetation of that new commonwealth.

One morning while the others were busy with their preparations for the trek through the jungle, Mrs. FAIRCHILD and I motored with Mr. BRANDTS BUYS to a point on the trail where I had seen a relative of the chestnut, a *Castinopsis*, the seeds of which I thought I could easily get. With our klawongs we scrambled up the steep slippery slope into the jungle, and the undergrowth closed in around us. It was stiff hacking and going. Suddenly not a quarter of a mile away we heard the unmistakable snarl of a tiger. When that snarl breaks the uncanny stillness of the forest it startles anyone! It was pretty near, but not so near as we were to the road, so we kept on. Another snarl still nearer: evidently the beast was coming our way. Another and another, each louder than the last, and finally BRANDTS BUYS said that while ordinarily tigers stalk their prey stealthily and at night, a hun-

gry man-eater will roar around and even attack in daylight, and as this one was so evidently coming our way he thought we had better get out of the jungle. Mrs. FAIRCHILD most heartily agreed with him, so we withdrew, though not before I had satisfied myself that there were no ripe seeds on the tree. A few days later, Mrs. FAIRCHILD and I, thinking that our nerves had been in no way affected by this experience, which we had both keenly enjoyed, returned to this same highway about dusk and made our way across an open field up to the edge of the jungle. I started collecting while Mrs. FAIRCHILD got out her little alcohol lamp and started to brew a pot of tea. Suddenly there was a crash right behind us. I think both our hearts were in our mouths. A great branch, loosened by some storm had fallen, although there was not a breath of air moving, but the idea of camping out alone in the forest as we had often done elsewhere, lost its attractions.

* * *

We spent nearly a week in Takengon, all of us together, before things were in readiness for the more strenuous part of the trip, the two-hundred-and-fifty-mile trek through the forest, but at last the coolies had all been engaged, the live chickens bought, the apportionment of the loads for each had been made and everything was in readiness. Who was to go? Mrs. FAIRCHILD was only a few weeks out of the hospital and could not go, and I had been having a good deal of trouble with my feet, an old case of flat-foot. Some one familiar with the material we had already collected had to remain to attend to it or it would be lost. I was not willing that one of the next generation should be deprived of the experience and DORSETT did not drive the car, so it fell to my lot, so to speak, to be left behind. It was rather a bitter thing, but then the whole region was so full of interest that I soon forgot it.

We had not imagined that taking leave of the boys, where the road ended and the trail into the jungle began, would be any more exciting than watching a group of friends disappear on the rear of a Pullman train, but it was. The trek was about as far as from Washington to New York. It was to take ten days or two weeks and there was no way of getting word to them during this time. We were to motor back to Medan, get up again on the high tableland from there, and meet them at the other end of the trail. Just at the last minute, as if to add spice to the excitement, BRANDTS BUYS came to me with the news that not fifty miles from where the trail passed, some Atchenese had, a day or two before, ambushed a small guard of Dutch and Amboinese soldiers, massacring most of them, and as there were to be foreigners in the party the Governor had thought it wiser to send a guard of soldiers with the expedition.

It was quite a sight to see them start. Beside the chief forester there had been added to the expedition Mr. FERNANDES, the local forester, so that the party consisted of five white men, with three ponies for those who got tired of walking, and an imposing number of coolies and soldiers.

As Mrs. FAIRCHILD and I stood on a pile of logs and waved farewell to the men as they disappeared single file up the mountain side through a gap in the jungle, I felt we were experiencing the great and rather melancholy feeling my great grandparents must have known when they bid good-by to their sons and relatives bound from New England for the great forest area of the Western Reserve. At least the stage setting of the end of a forest trail was there, and the dangers, real or imaginary, were much the same.

With the let-down feeling that comes after seeing friends off, we motored back to the pas-sangrahan and went to work on the seeds and plant specimens. There is something exciting about packing up seeds you have gathered and in which you have great hopes. There is a keen pleasure in gloating over your herbarium specimens as they dry in the blotters; the data must be attached to them, and every morning they must be aired and the blotters changed or they will mold, and while Mrs. FAIRCHILD and I found the task of saving what we had gathered in the jungles no easy one, particularly when we got back to the steaming lowlands and found hundreds of specimens in peril, I think we both look back to the herbarium days in Sumatra with a good deal of sentiment.

The long black log dugouts of the Gayoes tied up to the little wharf looked very inviting and one day we took an oarsman and paddled across in one to the far side of this enchanting Lake Tawar. The dugout has none of the balance of a cayuka on the Chagres, but is more like a birch-bark canoe in its temperament. We got across all right and found ourselves among some of the most peculiar clump bamboos I had seen. Their rhizomes formed great mounds higher than one's head and from the tops of these irregular mounds rose the tall plume-like stems. There were two kinds, the "Bœloe Besar" and the "Bœloe kechil," the large and the small, in other words. It took me some time, even with the help of the Gayo boatman, to get rhizomes of these species for the post. One lot arrived dead, but the other was reported alive when it reached Washington.

I picked up a local native and he guided me up one of the ravines that led into the pine forest above us, Mrs. FAIRCHILD preferring to remain behind. It was a day that reminded me of Italy. We climbed on and on, my guide muttering something all the time that I could not understand. At last we came to a little clearing in which was a single pine, and under it a tiny thatched hut with a floor made of pebbles from the beach, evidently the grave of some holy man. I saw that my native guide was awed, and I realized that, standing side by side before it, he and I were looking into the same universal mystery and that our feelings were in no way widely different. All the heredity and environment which had been mine gave me no particular advantage over him when it came to the matter of death. He had wondered about it, so had I. He had not been able to solve it, neither had I. The chief difference between us lay in the amount of superstition we accepted. For him the world was full of spirits and ghosts; every accident of his life was due to the machinations of his imaginary world. For me the spirit world, in his sense, had been demolished. I had learned to explain the occurrences about me in another way, which, while not dispelling the mystery, had dispelled the superstition and fear. I have often thought of him, that Gayo guide.

He had a superbly fashioned klawong, mine was a poor cheap thing I had bought of a Chinaman in Takengon, and I think he pitied me. He

felt of mine, then he struck the air viciously with his, and I gathered from what little Malay he spoke and I understood, that with his he could fell a man at a blow.

We tarried a few days at Takengon, increasing our collections and also our fondness for that idyllic spot the longer we stayed, and then set off for Medan. As we neared Langsar, we passed through plantations of what I recognized as West African oil palms (*Elæis guineensis*). The immense fruit clusters lying on the ground and the numbered labels everywhere indicated that it was some kind of an experimental plantation where seed selection was going on, but as I could find nobody who was in charge of the plantation, I had to leave without finding out much about it. From what I heard afterwards in Java, and from what I saw in West Africa a year later, I am prepared to believe that the West African oil palm may be the next great industry of the Oriental tropics. Like the date palm, it has the advantage of increasing its yields with age, at least for thirty years. It is adapted to the rainiest regions of the lowlands, and it produces a staple article of commerce for which there is a steady and growing demand. The kernels, as well as the pericarp or fruit flesh, are extremely rich in oil; in fact, the production of oil per acre is double that of the coconut. Over 130,000 tons of the oil and 400,000 tons of the kernels came onto the market in 1916, and by 1922 as many as 28,000 acres had been planted to the palm on the east coast of Sumatra alone. With their characteristic flair for valuable plantation crops and their unceasing and painstaking investigation of every development, the Dutch have studied the question of artificial pollination, pruning, seed selection, manuring, in short are making exhaustive researches into all its phases. Figures as high as $200 an acre gross for plantations from their fifth to their thirtieth year are among the estimates of possible returns.[2] What the Oriental plantations did to the Brazilian rubber industry they may do to the West African oil palm industry; capture the market with their product.

After two hectic days spent in Medan getting off shipments of plants, we got in touch with the owner of a charming little hotel at Kabandjahe, in the Bovenland, a day's run by auto from the Southern end of the trail where the expedition was to arrive. He put at our disposal a little house, once the home of the forester, so we motored up to look at it and found it just what we wanted, and the next day pushed on over a most remarkable road to Koetoe Tjane, which lies in a rainy valley between the mountains where the clouds often hang so low that they resemble drifting masses of fog on the landscape.

A sharp attack of indigestion during the night prevented my pushing on the following morning, but Mrs. FAIRCHILD met the expedition as it emerged at Lawe Aonau, thirty miles up the valley, and brought the party in, and by evening we were all together, bag and baggage, collections and exposed films, in the forester's house at Kabandjahe. No place could have been better adapted to the purposes of seed packing and plant drying.

The trek had been a success. The natives everywhere had been friendly, and DORSETT, among other interesting finds, had discovered a wild relative of the grapefruit, probably *Citrus hystrix*, and had brought some of the large fruits to show us. It formed a tree thirty feet high and its fruits were 4½ inches through. It is not an edible species, but what its resistance to the many diseases of the grapefruit may be, or what it may contribute in disease resistance to future hybrid citrus varieties, or whether it will prove a valuable stock on which to graft the grapefruit, are all questions whose answers depend on the growth and development of the four tiny seedlings that grew from the only seeds to reach Washington alive.

Interesting tropical acorns, looking in their immature state like green jade, several remarkable species of rubus which grew at an altitude of 5500 feet, representatives of the tropical grape genus *Tetrastigma* with clusters of blue-black fruit, many species of ficus for the Florida collection of this genus, a tropical euonymus, an extraordinary hydrangea, a superb clerodendron, *Berberis nepalensis* resembling the Oregon mohonia, a stunning celastrus with dark pink fruits, and numerous other interesting plants were brought in by the party.

GRAHAM made a valuable collection of butterflies, found one of the most remarkable of the tropical raspberries and discovered the larvæ of a new species of *Lampromya*. JIM made a remarkable collection of photographs illustrating the forest and jungle character of the whole "Atjeh Onderhoorigheden," as that portion of North Sumatra is called on the maps of the Dutch Government, and copies of these were presented to the Forestry Department of Sumatra.

Although we tied ourselves down to the task of saving specimens and packing seeds, we took time to have a glimpse of the country about Kabandjahe. It seemed hardly possible that this superb highland region, "Het Bovenland," could have been so recently occupied by European planters. Twelve years before our time a forester had refused to live there because of the cannibalism of the natives, and while this report may have been overdrawn, the very fact that there was such a report seems hardly credible today. At Brastagi, about twelve miles from Kabandjahe, we found the modern hotel full of golfers, among the guests as many Britishers from the Malay States and British India as there were Hollanders. Individual mountain villas were building everywhere around it and the whole place wore the aspect of a mountain resort. Because of the million acres of highland to roam over and its drier but quite as invigorating climate, Brastagi has already become a formidable rival of Newara Eliya in Ceylon.

We were in the region of the famous Battaks, and one of their characteristic villages was near by. The houses are all built for protection against enemies, standing on piles high above the ground with plenty of room for the pigs underneath. They are securely shut at night and the short ladders leading to the doors are taken up. Indigo is the universal dye of the clothing of Battak women and we saw their dyeing pits down by the stream. They were very crude affairs, just holes made in the rocks in which great bundles of the fresh stems and leaves of the indigo were put, weighted down with stones, soaked with water, and left to ferment. They seemed to be community affairs as far as

[2] RUTGERS, A. A. L., "Investigations on Oil Palms," publication of Experiment Station A.V.R.O.S. Medan, N. I., 1922, p. 111 and Appendix IV (an extensive bibliography is given).

we could see. Primitive looms were in use everywhere, but the weaving done on them was very fine and the designs were often beautiful, each village seeming to have its own distinctive patterns. Mrs. FAIRCHILD, who is much interested in the Javanese batik method of dyeing fabrics, was disappointed to find that there is no more connection between batik and Battak than a similarity of names.

I wonder if any anthropologist has worked out the origin of the remarkable roofs of the Battak houses. Who were the architects and how did they start a style with so much that is graceful and original in the sweep of the roof lines and the proportions of the gables? I can only compare their beauty with that of the gracefully made wasp's nest one sees in the barn, or the hanging oriole's nest in the orchard.

One of these villages we found completely surrounded by a thick living hedge of bamboo, the masses of whose rhizomes rose as high as our heads before the tall culms were produced. These culms were everywhere in use as structural portions of the houses and if one were to take the bamboo away from the Battak, his civilization would collapse like a house of cards.

As we were returning one evening from a trip, we passed what I am sure are the most remarkable scarecrows in the world. Birds are one of the greatest pests of the paddy fields and wherever one goes in rice growing countries, one finds all sorts of contrivances for scaring the flocks of rice birds away. The Battak makes his entirely of bamboo. He digs a hole six feet deep and plants firmly in it a six-inch bamboo pole twenty to twenty-five feet long, setting it perfectly upright. He makes a basket-like pulpit strong enough to hold a man, and leaves about fifty of the strong elastic bamboo strands with their loose ends sticking up, as though the basket were unfinished. This is fastened on the top of the pole before it is set in the ground. A second pole with notches in each joint to serve as steps is planted a short distance away from the pulpit pole and fastened to it. To each of the loose ends of the pulpit-basket is attached a long thin bamboo twine, the other end being fastened to a stake at the border of the rice field which it is desired to protect. This bamboo scaring twine hangs in a gentle curve above the ripening rice, and the fifty are so spaced that they cover the entire field. During the daytime a scarecrow operator sits always in the pulpit and shakes the string nearest to any flock of birds that may alight on the rice, frightening them away. When we passed, the sun was setting, the birds had gone to roost and the man was just descending from his watch.

The weeks had flown, spring was coming, and Manchuria would soon be calling the DORSETTS. We had the alternative before us of staying in Sumatra or going to Java. We chose the latter course, because the older civilization offered much more for the purposes of the expedition's quest than the wild jungles whose riches are only to be dug out by long sojourns at various and scattered headquarters.

Our last excursion was to the Toba Lake at Harangaol. In the guide books of the late nineties this remarkable lake is dismissed with a brief paragraph saying the trip from Deli to Lake Toba is not dangerous. Today it is within a day's journey by auto of Medan, and already charming little hotels are clustering around its shores.

Once out on the Bovenland, the fact begins to dawn upon you that you are in one of the most amazing places in the world. Your eye sweeps a far horizon as it does on the plains of Montana, but here innumerable volcanic peaks rise around you and your car is traveling forever along the border of some deep ravine, filled to overflowing with the crowns of giant tropical forest trees.

In an area forty miles square, with Kabandjahe as a center, there appear on the map fifteen streams such as those you are just skirting, all so far below that the water can neither be seen nor heard, while the twelve volcanic peaks, some of which are smoking, range in height from 4000 to 8000 feet above the sea. Let the tourist-laden aeroplanes once land upon it and who can say what will result? I predict it may become the greatest health resort in the whole tropical world, attracting to it the wealthy winter golfers of Europe and the sunburned summer golfers of Australia. A million-acre winter and summer play place, surrounded by fascinating tropical jungles at an altitude of three thousand feet is something to attract the crowded aerial craft of the future.

As we were driving through these marvelous highlands, getting out every few minutes to collect leguminous plants or grasses, or trying, often in vain, to reach fruits that were tantalizingly near us in the tops of the trees which rose from the ravines by the side of the road, suddenly Toba Lake came into view. It is larger than the lake of Geneva, with an island in its middle that is twenty-five miles long and its mountainous sides are clothed with a vegetation it would take a botanist a lifetime to describe. We drove down the winding road to the shore, gathering plants as we went. Once I brushed against the recurved spines of a vine, *Cesalpinia sepiaria*, and was brought to a standstill. For a moment I seemed to be on the keys of Florida among the knicker beans again, and indeed this was a relative, with much the same habit.

When we reached the lake there was an idyllic beach on which some wealthy Hollander had built a rather pretentious house to which he could come to get cool. On the beach I found a legume which I took to be a *Crotalaria*, that had the largest number of seed pods on it I had ever seen on any legume. We found another one beside the road which turned out to be *Crotalaria striata*, a species which was introduced into Florida twenty years ago. It is today one of the most valuable cover plants ever brought into that state. According to Prof. STOKES, who has been studying it for several years, it is "a soil building crop for poor, thin, sandy land, being a good seeder, a rank grower, free from serious diseases, and when turned back to the soil, a crop which adds large amounts of nitrogen to it. Both A. ZIMMERMANN of Amani, German East Africa, who sent the seeds to America, and C. V. PIPER of Washington, who introduced it, must have been pleased that from a handful of seed, vast fields of the legume are enriching the soil of Florida each year. Can anyone build himself a better monument than this?

The water was too inviting for DORSETT and me to resist and we found it as refreshing to swim in as it was beautiful to look at. Some day we would like nothing better than to spend a month on the shores of the Toba Lake, collecting.

* * *

When we first came to Sumatra, we were told

of a Plant Garden halfway between Medan and Brastagi at an altitude of 1600 feet and we had stopped there on our way up. Its director, Mr. J. A. LOERZING, had received us with great cordiality and showed us over its incomparable trails, for in place of being a botanic garden of the conventional type, it was a real jungle garden teeming with things of fascinating interest to us. Mr. LOERZING was a real enthusiast, and had gathered together a small herbarium and a library, and had acquired a wide acquaintance with the flora of Sumatra. There was a little guest-house, where visiting botanists were welcome, and he had invited us to come and stay there when we finished the trek through the jungle, so on leaving Kabandjahe, DORSETT and I took our specimens and notes and established ourselves there for several days. We had two wardian cases sent up from Medan, and filled them with plants, many of which are now growing in gardens in the Western Hemisphere. With Mr. LOERZING's help, we were also able to determine many of our specimens collected in Atcheen.

Things have since gone badly with its director, I hear, and the management has been put in other hands. I trust that the government will find it possible to build up this station, keeping its unique charm as a jungle garden, and that botanists from all over the world will continue to find a welcome there, for it deserves to be better known to the world.

Of the many rare and interesting plants which we secured at Sibolangit, the Moluccan rattan palm (*Pigafettia elata*) stands out clearly in my memory for, though only six and a half years old, its great spreading fronds were tossing in the wind sixty feet above our heads. As we saw it in Sibolangit, it seemed as stately as the royal palm and twice as rapid a grower, and the straight, cylindrical stem is a beautiful brilliant green for the upper third of its height. A handsome wild banana (*Musa glauca*) with enlarged base, and leaf stalks of a light bluish gray tinge, was new to me, and if its growth in Florida compares with that in Sumatra, it can scarcely fail to make a place for itself among the stately ornamentals of the gardens there.[3] I saw for the first time the long-jointed bamboo, with nodes five feet apart, out of which the Battaks make their blowguns. It is also from the thin-walled stems of this species that the musicians of the Javanese kampongs make the bamboo pipes with which they fill the moonlight nights with a strange sad music. We planted two wardian cases with some of the rare bamboos so much used by the Battaks and of which the Western Hemisphere seems to be ignorant, such as *Schizostachyum brachycladum*, *Melocanna humilis* and *Schizostachyum latifolium*. We also put in relatives of the bread fruit, *Artocarpus elastica*, and an undescribed species called "roepas" by the natives, who cook and eat it as the Pacific Islanders do the breadfruit. *Turpinia pomifera* was a wonderfully fragrant flowering tree; *Eugenia aquea* was one of the showiest fruiting trees I ever saw, with small pear-shaped translucent crimson fruits scattered by thousands over it; *Actinorhytis calapparia* is a palm ideally suited for small gardens, where its slender graceful trunks would make beautiful miniature avenues; and the fast-growing tree *Alangium begoniifolium* var. *tomentosum*, grown for poles, with a brief life period, like the papaya, may find a place in the agriculture of Central America, and possibly too in South Florida. The most curious tree of the whole garden was the bird-catching tree, *Pisonia excelsa*, whose fruits are covered with a gum that is as sticky as glue. Small birds that alight on it when the fruits are ripe get their wings so glued together that they cannot fly and often fall to the ground below. Unfortunately we were there before the fruit was ripe.

Ever since my first visit to Java I have wanted to introduce somewhere into the western tropics the most curious of all the tropical cucurbits, *Macrozanonia macrocarpa*. The tiny seedlings of this vine start life with a slender stem and leaves no larger than that of the smallest *Ficus pumila*. Clinging to the bark of the nearest tree, this tiny thing grows up into the large branches of the tree and there the leaves become larger just as they do in the case of the climbing ficus, but still it clings and goes on up. When the vine finally reaches the tops of the forest trees, its leaves enlarge enormously until they are a thousand times or more the size they were when young. The fruit borne in the tree tops is as large as a pumpkin, and when it ripens, a square hole opens in the bottom and, with each gust of wind, there escape hundreds of the most perfect flying or rather soaring seeds I have ever seen. I once imported one of these gourds full of its seeds for Mr. GRAHAM BELL to experiment with in the days when he was working with his kites. The seeds seem to be short-lived but I found a single plant for the wardian case.

We spent some fascinating days with Mr. LOERZING, following him up and down over the trails — by no means always safe — of his garden. A tropical *Mucuna* has stinging hairs on its pods, so poisonous that to brush against them is agony; the native *Laportea* is a nettle so vicious that to fall among its leafy stems would drive one almost insane, while the possibility of meeting a cobra or a green viper made one cautious about where one walked.

The monkeys chattered from the tree tops. The most amazing chorus of tropical birds used to awaken us at dawn. The shrill scream of great green-banded cicadas was earsplitting. The sound of water coursing down the pebble-lined waterways through the garden and the hum of insects at night, all come back to me as I write. How I should love to stand once more at moonlight on the cliff near the guest-house in Sibolangit and look out over the great tree-ferns across the sleeping valley filled with its thousands of species of living forms, the virgin tropical forest!

[3] It has grown well in my garden in Coconut Grove and fruited there; indeed, I already have second generation plants, but it is not as graceful as in Sumatra. It may prove a good fiber plant.

# III. GARDENS OF THE EAST FROM THE AIR (1940)*

We fully expected to return to Java for a longer stay after our coming visit to the Moluccas. However, while we were waiting on the Junk's repairs, there was time for a brief visit to Buitenzorg by air. To fly over an island about the size of Cuba, which has thirty-five volcanos, seventeen of which have been active in historic times, should be exciting enough. But it meant more than this to me. It meant looking down on "the very garden of the East, and perhaps, upon the whole, the richest, the best cultivated, and the best governed tropical island in the world," as WALLACE described it eighty years ago.

When WALLACE saw Java in 1865 there were only fourteen millions of the species *Homo sapiens* living on it, and he wandered through vast forests where he saw "beautiful and varied and peculiar species of insects, birds and other animals found nowhere else upon the globe." I wonder if he would view with equanimity the increase from fourteen to forty millions of that destructive animal, man, at the expense of other forms of life; even the extinction of creatures quite as beautiful and not so destructive.

As the plane of the K.L.M. cleared the suburbs of Soerabaya and the countryside was spread out below us, it was evident that Java was crowded with little homes. These were clustered together in kampongs, and clumps of tall feathery bamboos marked their whereabouts. I could see the garden patches, the bread-fruit and durian and mango trees near by, and the irrigating canals feeding the "sawas," or rice fields with water from the mountainside. Where were the corrugated galvanized-iron roofs that stare up at one from other tropical landscapes? There were none; roofs of bamboo-shingles, thatch, or weathered tile were universal. Little children looked up at us as they played in the neatly swept dooryards. I could see the turtle-doves in their bamboo cages swung from bamboo poles stuck in the ground. I knew the walls of the houses were made by splitting bamboo stems into strips and weaving them together; that the floors were made of the same material; the drinking cups, the buckets, the brooms, the spoons, the forks, and every imaginable utensil in the house likewise, all from plants "grown on the place," and that the boundary lines which divided the various households were some pattern of bamboo fencing.

As we climbed higher and the sawas reflected the light from the clouds, I could see how they descended, in an almost unbroken series of large flat terraces, from well up the hillsides to the seacoast. There, great ponds resembling the sawas took their places, ponds in which vast numbers of fish were raised for food — not so profitably, however, as I learned later. We were travelling over Middle Java, headed for our first stop, Semarang — a hundred miles away, over country so densely populated that from 250 to 500 people were living on each square mile. Yet in this area below us there is not shown on the map a town of more than a few thousand inhabitants. They do not live in towns, these people. The Javanese are skilled agriculturists who prefer the country. But their families come on so fast that the problem of food has become a serious one; one with which the Netherlands Government has long struggled.

I had hoped we would see at least one of the smoking volcanos as we flew past, but although the Merapi was active, fleecy clouds shut it from view. Here and there were forest plantings of teak; tea and cinchona plantations; *Hevea* rubber patches belonging to the Javanese; and the larger, light green areas of sugar-cane, planted on lands rented by the big companies. If only the plane had been a blimp! I can imagine it would be fascinating to make a careful and leisurely study of Java from the air.

Bandoeng was once a quiet, little, tree-shaded place where Hollanders tired of the heat of the lowlands went to "cool their noses," as the local saying is. I have in my orchard a fine souvenir of our stay in Bandoeng: a red-fleshed pomelo. When I tease out its wine-red segments to adorn a salad, I think of Bandoeng as it was then. But when we landed on the airfield the noise was so terrific I thought my head would split. For there were ten training planes all tuning up at once. Bandoeng had become the chief center of Army air activity of the whole Netherlands Indies. This was only five weeks before the fatal tenth of May, when the Germans invaded Holland.

To get away from Bandoeng as fast as we could was our one idea; so we hired a car and were soon climbing over the Poentjak Pass, and without even stopping to see my loved Tjibodas, which I heard had changed so that I would not know it, we swung into Buitenzorg in a pouring rain. But it generally rains in the afternoon in Buitenzorg at the beginning of the Southeast Monsoon; so we were not disconcerted.

As we drove into the main street that skirts the Botanic Garden or "Kebon Besar," I looked for the Hotel Bellevue, where we had spent such delightful days watching the sunset over the Salak and the shadows lengthening across the palms along the river — a scene which Mr. LATHROP used to declare was one of the four most beautiful in the whole world. It was gone; turned into a government office-building. One of the back porches still remained, and later we made our way to it to watch a sunset, for no views but those of the busy street were possible from the new Bellevue-Tibbets Hotel. The disappointment of "going back home and finding everything changed" met us in full force, for even the famous Waringian allee of enormous ficus trees which used to stand in the Palace grounds had been cut out.

The peddlers, with their baskets on shoulder-poles, exposed their fascinating wares, and brought their strings of mangosteens and ramboetans and doekoes to our porch sitting-room in the new hotel as they used to do. But the rather bare "Deer Park" around the Palace, with a busy street between, was a poor substitute for the volcano Salak and the Tjisadane river of the old Bellevue.

But the Kebon Besar was there, and Dr. VAN DEN HONERT called for us and took us to it as the sunlight cast its slanting shafts of light through the great trees. I was glad that this garden, which was established in 1817 by REINHARDT, when JOSEPH HOOKER and ASA

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GRAY were still little boys, had been placed n a slowly growing city. There had been changes enough, of course, in the plantings, but the magnificent avenue of *Canarium* trees, which was planted in 1832 and which I first saw in 1895, is more glorious than ever, and its beauty thrilled me as it has never failed to do. No city streets have been cut through the Botanic Garden, and no skyscrapers have gone up around it to dwarf the stateliness of its beautiful trees, as they have around so many of the old gardens of the world. As Dr. VAN DEN HONERT showed us a small addition to the garden, I could not resist the wish that somehow, somewhere, someday, a garden large enough to accommodate the spectacular and valuable tropical trees of the world might be established. This one in Buitenzorg has, it is true, over 200 acres, but these acres have been filled for half a century, and it would require a garden ten times the size to accommodate even a fraction of the interesting trees of the whole tropical world. Many such gardens as this, in many places, in different climates, may come some day when man passes from his present infantile state into manhood, and discovers that the forests of the world are going up in flames.

Dr. BAAS BECKING, the Director, was in Holland, whither he had gone to gather an increased staff of scientific men for the Garden; but Mrs. BAAS BECKING had recently returned, bringing her children with her, for she felt that Java was a safer place than Holland. She arranged a delightful dinner at her house to which various members of the scientific staff were invited. There was a tenseness about it, however, for the conversation turned often to the war and to the danger that something might happen to the Director. A few weeks later came the reality: Dr. BECKING was unable to leave Holland because the Germans had invaded it; and later still, the floods of war swept over Buitenzorg itself. I am glad that none of the party had any idea of what was pending. Where are they all now?

The next morning I met the systematic botanists in the Herbarium: Dr. VAN SLOOTEN and Dr. VAN STEENIS and Dr. EYMA, who showed me specimens of interesting palms and flowering trees and other useful plants which they, or others, had collected in the various islands of the Moluccas, whither we expected to go. As I run through my notebook I find that I set down, "JANSEN, Resident in Ambon, interested in science, according to VAN STEENIS." We were to see much of the JANSENS, as I shall relate.

While in the palm quarter one morning I met Mr. DAKKUS, the only one of the Garden staff whom I had known before, and I was pleased to find he recalled my visit. When we got to his office he remarked:

"There is a man here who has something for you. He wants to see you. I'll 'bell' him." Before I could find out who the man was, Mr. DAKKUS came back from the telephone. "Yes, he says he has got it and will bring it to your hotel. Didn't you write out here for some sort of musical instrument or other?"

Then of course I recalled that three years before, when it was proposed to start a Palm Museum in the Fairchild Garden, I had written to Dr. BAAS BECKING, asking him if there would be any way of getting from the island of Timor a strange musical instrument, made of a leaf of the lontar palm and a joint of bamboo, similar to one which Mr. LATHROP and I had seen in 1899 and had purchased for the Field Museum. It was this request that the "Houtvester," C. DE VOOGD, had taken the pains to fill. When he brought it, we discovered he had lived on Timor and had many good photographs of the island, which is dry, like North Australia, and has many casuarinas and eucalyptus and lontar palms, and would well repay a visit when we returned from the Moluccas. The palm-leaf guitar is now in the Palm Museum — but I wonder where DE VOOGD is?

This morning, as I was pondering on how I could describe my sensations upon entering for a third time the Palm Collection for which Buitenzorg is famous, my eyes rested upon a charming species which bears the specific name of *treubiana.* It is dropping its pretty fruit beside my mango tree on The Kampong; *Syagrus treubiana* is its name.

It was TREUB who gave me my first glimpse of the world of palms; a world which has fascinated much greater minds than mine, and which would fascinate many more if they were once to turn into its glades and leave the dusty streets of commerce behind them.

I had been a young man of twenty-five when I followed Mijnheer TREUB along the gravelled paths of the old Garden, which then was already nearly eighty years old — and now, in April of 1940, I was walking there alone, forty-six years later and on my seventy-first birthday, and in my consciousness was the marble bust of TREUB which I had just passed by in the laboratory that bears his name.

It is of course a very different thing to visit the palms in their own native haunts than to see them in a collection. However, the gracefulness of their forms is the same, the charm of their exquisite details is not changed, and the beauty of their immense flower clusters is perhaps even enhanced, for in the wilds these superb features are often so high above our heads that we cannot see them clearly or scent their fragrance.

To appreciate a palm you must view it as you would a work of art; as if it were a marble statue or a piece of bronze. For unlike a tree with its millions of leaves, a palm has only a few leaves; but these are immense affairs, and the arrangement of them gives character to the "piece." Moreover, palms are almost always green, except when they flower or fruit, and even then they are never covered with bloom as is a cherry tree, but have here and there a brilliant cluster of fruits — scarlet or golden-yellow or sometimes black. Their flowers are mostly white. The grace of their slim, straight trunks of grey or brown, with the leaf scars making ring-like marks around them, like the faint modelling of a statue, comes to have a curious charm for those who live among them. But their glory is in their leaves, those structures so different from the leaves of ordinary trees; so different that even the moonlight when it is reflected from them strikes the eye in bands and not in spots of light. Then too, the whispering of the palm leaves is far different from the sighing of the pine needles or the rustling of the oak and maple leaves. There is an especial softness about it.

I felt this difference when I wandered down among the lily ponds, around which and upon whose bordering slopes the great collection of palms in Buitenzorg is planted. The "Lady from Philadelphia," who had a Ben Franklin

Oak and to whom palms appeared as "feather dusters," nothing more, would, I am sure, have found her ideas changing had she walked with Mrs. ARCHBOLD and me among the palms of Buitenzorg.

For we would have taken her to the Sealing-wax palm, with brilliant lacquer-red leaf-sheaths scattered among the delicate plumes; or we would have made her look to the top of a giant *Corypha*, loaded with masses of white flowers, a half a ton or so, which mark the close of the life of the great giant; for like the Century Plant it flowers and fruits but once — at the end of its existence. The Lady might have recoiled from the group of *Zalacca* palms, completely covered with brown spines several inches long; and if the tip of a Rattan in the quarter where these climbing palms have been confined had touched her dress, even lightly, she might never have extricated herself unaided. She could not fail to fall in love with the immense-leaved *Licuala* from New Guinea, with slender leaf stems ten feet long, ending in fan leaves spread out like a wheel. And she could not fail to wonder at the South American *Scheelea*, with waving fronds that are thirty-five feet long, and drooping bunches of fruit eight feet or more in length. The Lady would have stood in wonder, as Mrs. ARCHBOLD did, at a giant from Cochin-China which bore no scientific name, but whose petioles alone were three feet across at their base and thirty feet long, ending in a colossal fan far too large for any giant to use.

I knew there had been many changes in this collection; but since it represented a great assembly of species some of which must be nearly a century old, it was in a measure a forecast — on a greater scale, of course — of what might be expected some day in the Montgomery Palmetum of the Fairchild Tropical Garden in Florida. Fully expecting to have a chance to spend some time in the collection in July, I contented myself now with notes on those which seemed the likeliest to be in fruit when we returned. Mr. DAKKUS promised me any seeds we wanted. As he most graciously remarked when we discussed the matter: "I shall be glad to fill any of your requests, for we have always considered you as one of us."

A note came from the Palace that Their Excellencies, the Governor General and Mrs. VAN STARKENBORGH STACHOUWER, would be pleased to have us lunch with them informally. I do not know what their definition of "informal" was, but it was certainly not the same as ours! We were met by several aides in full uniform; I was taken to be presented to His Excellency, while the ladies were given an audience with Her Excellency. After a few minutes, we were gathered up again and escorted back to the main entrance hall, and there we stood in line with other guests until the Governor General and his lady appeared and led the way to the dining room. After all, we were lunching with the personal representative of Her Majesty the Queen of the Netherlands, the Governor General of the whole Netherlands India, comprising a conglomerate population of over 60,000,000 people who have always been accustomed to associate authority with certain regal formalities.

At the table, however, we had a delightfully friendly time. Madame VAN STARKENBORGH STACHOUWER (yes, they say it all each time) was an American, and we found mutual acquaintances. I could not resist making the suggestion that the site of the old Bellevue Hotel should be converted into a park where people could go in the late afternoon to enjoy one of the most superb views in Java.

We had asked about the Moluccas, where we were bound, but only the Governor's Naval Aide had been there. As we left, he counselled us to be sure to see Herberger Straat, which had the reputation of being the most beautiful passage in the whole East Indies. We went out of our way to see it later, but, as viewed from the rather low level of the *Chêng Ho's* deck, it did not compare favorably with others we saw.

* * *

The afternoon train brought us into Batavia, to the old Hotel des Indes. It is inevitable that a small hotel which grows into a big one should become less attractive and more formal. Gone were the grand old ficus trees which used to shade the great square between the wings where the simple suites of rooms once were, and the glamour of the place, as I remembered it in the nineties, had departed.

I had bid good-bye to my friend OCHSE on the verandah of the Hotel Bellevue in Buitenzorg in 1926, where he came to bring me some beautiful fruits of the "Pandan Wangi" pomelo which I have described elsewhere. OCHSE had sent me two of his books, remarkable productions, one of them covering the hundreds of vegetables used by the Javanese, and the other the fruits. Both of these books are the product of the printing establishments of Archipel Drukkerij of Buitenzorg and the firm of G. Kolff and Co., Batavia, and are so outstanding that I give their complete titles here: J. J. OCHSE and R. C. BAKHUIZEN VAN DEN BRINK, *Vegetables of the Dutch East Indies*, English Edition of *Indische Groenten*, 1931; and J. J. OCHSE and R. C. BAKHUIZEN VAN DEN BRINK, *Fruits and Fruit-culture in the Dutch East Indies*, English Edition of *Vruchten en Vruchtenteelt in Nederlandsch-Oost-Indië*, 1931.

Both books represent the close cooperation of the various scientific men of the Botanic Garden and of the Department of Agriculture of Buitenzorg, a cooperation to which Dr. OCHSE gives full credit. They are superbly illustrated. The artists who made the pen-and-ink drawings, M. SOEPARNO, M. KARDJONO, and M. MARJOM, have equalled or outdone anything of the kind turned out by American artists, while ATJE SOLEIMAN of Buitenzorg (a Sundanese), in his renderings from nature of such tropical fruits as the Mangosteen, the Durian, the Mango, the Avocado and many others, has surpassed in accuracy and delicacy of coloring any representations of tropical fruits I have seen anywhere. Even the noted illustrations of EICHHORN lack something of the genius of SOLEIMAN's plates. These two remarkable books should be in the libraries of America, for they portray three hundred tropical vegetables and over fifty of the finest fruits of the Orient.

It was with misgiving that I learned in Buitenzorg that my friend J. J. OCHSE had been promoted, and now held a most important position close to Dr. H. L. VAN MOOK, the Director of "Economische Zaken" (Economic Affairs) — for who can enter the doorway of bureaucratic affairs and not have his hobby of a lifetime taken away from him?

As soon as we reached Batavia I hurried over to his "Kantoor" — a word I like better than our "office" — and after wandering around for some time in the maze of other kantoors and interrupting many clerks, I found his assistant, Mr. DE JONG, who knew of our longstanding friendship and soon got us together. OCHSE was in the laboratory where the economic uses of the various plant products of Java were being investigated — the methods of preserving fruits, and making jams, jellies, wines and other products.

Yes, of course I wanted to go out to the Horticultural Garden at Pasar Mingoe; so the next day several of us drove out through the suburbs to the "Proef Station," a horticultural experiment station, without which it seems extremely difficult to raise the general level of any plant culture in any country. I looked with especial interest at 12,000 seedlings of the Durian, upon which were to be grafted the finer varieties, one of which, the Koening Tjomas, was said to be especially delicious.

I could not help thinking, as I peered under the palm shade that covered those seedlings, how strange it is that so "ill-smelling a fruit" should have become famous throughout the whole world of the reading public, while the Ramboetan, which has no such odor but is also a perfectly delicious fruit, should be almost unknown.

Who knows what will be the future of the durian? There are durians and durians, and some of them keep longer than the conventional two days before they smell badly. I met a missionary who lives in Dutch Borneo, who had found there three distinct species or varieties, including one with red flesh, and one that none of his friends found to have an objectionable odor. The question will resolve itself into what can be done with the durian to fit it for the air-commerce in tropical fruits that is fast approaching.

What interested me perhaps more than these durian seedlings was a nursery of avocados, for this strictly American fruit had not made its appearance in Java when I first visited the Orient in 1896, any more than it had become a table fruit in Florida and California by that time. Half a century had passed, and whereas this nursery in Pasar Mingoe was one of the largest in Java, there had been developed in America thousands of acres of orchards of avocados, associations of hundreds of avocado growers, and a commerce represented by the shipment of hundreds of carloads of the fruit across the continent.

This comparison is not made in a boasting spirit; it is made to emphasize the vagaries of taste, and the power to overcome food prejudices that lies in advertising. Perhaps the Javanese don't like the avocado as much as they do the durian, but I surmise that there are still many millions of them that have never had a chance to taste it. Besides, there are questions of finding the best places in which to grow the avocado, and of creating varieties suited to them. Furthermore, there are new diseases and pests to contend with. It is this type of important work that the Horticultural Station of Pasar Mingoe, and the other experiment stations of the Archipelago, have been engaged on.

OCHSE wanted me to see the Fishery Laboratory in Batavia, which came in his department; there had been American research students working in it, Dr. G. MEYERS of Berkeley, California, being there at the time. Two incidents of the visit that seemed of no particular moment in 1940 stand out in the light of subsequent events. On the table in the large working-room lay a beautifully illustrated book on the aquatic plants and animals of Japan. It was published by the Tokyo Fisheries Society of Japan, and I wished it were on the Junk for our use in the Moluccas, for we had been unable to find any book with which to identify the fishes we saw. As we left, OCHSE remarked on what an ideal research boat the *Chêng Ho* would be, if left in Batavia for their use in getting around to the various collecting fields of the Archipelago. "Our boats are too small," he said. "Here is one being repaired now." As I peered under it to see the mechanic at work on the propeller he added, "A Japanese, of course. Our own natives are not very mechanical."

During luncheon next day with the OCHSES, their daughter gave us an account of her school experiences in Perth, West Australia. It was the first intimation we had of the close relations which have grown up in recent years between Netherlands India and Australia. After all, the coast of Australia is nearer to Java than Panama is to Florida; and the cool mountains of Java are as attractive to those suffering from the desert heat of Australia, as are the cool dry winters of West Australia to those tired out with the moist heat of Java. Mutual understandings and friendships have multiplied here, as they must throughout the world, shrinking as it is with each new development of air transportation. . .

At tea, which we took with Consul General EARLE DICKOVER and his wife, Mr. DICKOVER complained that his little garden was simply alive with immense snails, and in order to keep anything growing there, it had become his nightly chore to go out and hunt them. A haul of 350 to 450 was not unusual, as the records he had kept showed. With a flashlight we went to look at them. I thought of the pest of land crabs in our own garden in Florida, but after seeing the damage the snails did, I am satisfied that we should not complain — snails are much worse. God forbid that we ever get them here.

Dinner with the VAN MOOKS was like a quiet dinner in Washington, for they both speak English and are widely travelled, and Dr. VAN MOOK had spent some time in the United States. He told us of his plans for the enlargement of the research staff of the Botanic Gardens and of Dr. BAAS BECKING's mission to Europe, where he had gone to pick out the scientific men who could carry out the plans. It was evident that he understood the rôle which scientific discovery would play in the development of this vast region, teeming with its races of humans, many millions of whom are just emerging from the lower levels and are wondering what "civilization" is all about.

Of the effects of the terrific impact of Western inventions upon those millions, Dr. VAN MOOK was probably less keenly aware; and of the invasion coming down from the North he could have had little suspicion. Singapore was "impregnable" in those days, and the American fleet was stationed at Pearl Harbor. Both he and Mrs. VAN MOOK belonged to the Netherlands Indies rather than to Holland, having both spent most of their lives in the East, finding there a larger field for their activities than they could

in Europe. Indeed, wherever we went we found that the number of Hollanders who now prefer to spend their lives in Java, and other islands of the Indies, has increased very much since the last war. This appeared to be due in part to the increased comfort afforded by electric refrigerators, fans, and radios — and also to a sense of security in living so far from the turmoil of Europe!

While we were at dinner, MARIAN's attention was riveted on the wall-covering of the dining room, and Dr. VAN MOOK seemed pleased to have it admired. "It's the 'Agel,' the material from which the sails of the Makassar praus are made," he said. "It comes from the leaves of the 'Gebanga' palm, *Corypha elata*." This palm is the same species as that known in the Philippines as the "Buri." Thanks to Dr. VAN MOOK's kindness, large specimens of this beautiful material are on exhibition in the Museum of the Fairchild Garden. Along the coast of Celebes, we had admired the sailing canoes, but not until we arrived in Makassar did we appreciate what airy swiftness these craft can attain by using this Agel matting.

* * *

Two and a half hours of flying took us back to Soerabaya. The pilot indicated to us in a general way the location of the emergency landing fields, but there was no evidence of the slightest suspicion of an invasion. I felt the romance which I always feel in a plane and which comes perhaps from my memories of that very first public flight of a heavier-than-air flying machine, the flight of GLENN CURTISS in 1908, when he flew a measured mile over the vineyards of Hammondsport, N.Y., thirty feet above our heads, and the dusk shut his landing from our view.

From those days in Soerabaya, which were filled with all sorts of doings, including a visit to DAAN HUBRECHT's sugar estate and final arrangements for getting off, two outstanding events remain in my memory. One was the day spent among the Lontar palms of Grisse with Dr. J. H. COERT, an amateur naturalist, during which I "made the acquaintance," so to say, of a real expert in the art of tapping these trees for their sweet sap. A man who has climbed, every other day for years, without climbing irons, to the top of a fifty-foot shaft, has straddled its giant leaves, and with a pair of wooden pincers has macerated its hard flower clusters to fit them for tapping, has a "story." It is a story which in my opinion is quite as fascinating as that of the line-men who hang on the poles and string the wires of our telephones. Our "expert" had one pair of pincers which he called "Gapit lakke," for mashing the male flower spikes, and another for the larger female flower spikes which was called the "Gapit prampoean." For the Lontar, like the date but unlike most other palms, bears its male and female flowers on separate trees. Botanists have sometimes disputed as to when sexuality in plants was discovered, and the suspicion is warranted that the date growers of Assyria must have suspected sexuality centuries before the scientific botanists. The sap collectors of the Lontars, I should judge, found out that their palms were of two kinds, and that only one bore fruits.

When I talked with this man, I found that there was much more to his trade than I had imagined, for when he climbed up into the crown of big leaves he not only pared down the sharp edges of the leaf stalks, which otherwise would cut his legs, for they are as sharp as razors, but he also gathered such of the leaves as were mature enough to be used in the making of baskets and hats, and so forth. Fermentation soon turned into toddy the sap he collected every day from the cut-off ends of the flower stalks he had mashed previously. Then, too, the sap he collected was often made into that delicious palm sugar called Jaggery, sweeter than barley sugar obtained from malted barley.

I found it fascinating to interview this expert, quite as fascinating as it had proved in my early days of travel to interview the brewmasters of Munich and Pilsen. But had I given this fellow a glass of beer, he would have spit his first mouthful out; and the Munich brewmaster would have thrown the toddy away. "*Chacun à son gout.*" . . .

# FELIX ALEXANDER VENING MEINESZ EXPONENT OF INTERNATIONAL COÖPERATION THROUGH GEOSCIENCE

*by*

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No history of science and scientists in the Netherlands East Indies would be complete without an account of the explorations of VENING MEINESZ with the splendid coöperation of the Netherlands' Navy.

Among scientists VENING MEINESZ is classified as a geodesist. He was born at 's-Gravenhage (The Hague) on July 30, 1887, as the son of S. A. VENING MEINESZ, Burgomaster of Rotterdam, and later of Amsterdam. He attended the "Hoogere Burgerschool" and afterwards the Institute of Technology at Delft, from which he graduated in 1910 as a civil engineer. In 1915 he obtained the degree of Doctor of Science from the University of Utrecht, where in 1927 he was appointed Professor of Geodesy. In 1937 he became chairman of his Government's Committee for Geodesy. In 1933, he had been elected President of the Association of Geodesy of the International Union of Geodesy and Geophysics.

VENING MEINESZ' national and international

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

honors need not be listed in this article, but his accomplishments should be briefed as an outstanding illustration of scientific imagination and method in the exploration of a fundamental physical phenomenon of the earth. The geographical counterparts of the Netherlands East Indies exist in such other archipelagoes as the West Indies and the Aleutian Islands. Due to VENING MEINESZ' geophysical and geological researches in the Netherlands East Indies we now know that their geographical and structural counterparts have probably reoccurred as great dynamic deformational rhythms of the lithosphere during the entire 1,500,000,000 or more years of our planet's geological history.

It has already been stated that VENING MEINESZ is by training and occupation a geodesist; a scientist who is primarily concerned with methods for determining the mass, weight, density, shape, and surface configuration of the earth — including such inequalities in relief as ocean basins, ocean deeps, continents and mountains. Primarily, however, a geodesist is an advanced type of surveyor or topographic engineer whose chief responsibility is to improve and perfect surveying instruments and methods. Had VENING MEINESZ confined his activities to the arts and practice of geodesy alone he would still be rated as one of the outstanding geoscientists of today. The story of how he so effectively transgressed the border lines of scientific departmentalism to the great benefit of geoscience is particularly significant as an illustration of his skill in national and international coöperative research and of his appreciation of the natural exploratory advantages of the sovereign territory of the Netherlands.

VENING MEINESZ' principal responsibility to his country was to determine local deflections of the vertical, or the deviation of the plumb-bob, in order to correct certain irregularities in the triangulation survey of Holland. A triangulation survey may be defined as the most precise method for the determination of geographic positions, or the location of first-order bench marks to which all local surveys are "tied in," or related.

VENING MEINESZ' great contribution to geoscience was his discovery of the linear belt or strip of negative gravity anomalies, that is deficiency of density, topographically expressed by the islands and oceanward troughs or foredeeps of the East Indian Archipelago. The outstanding characteristic of VENING MEINESZ, like that of all great scientists, is his interest in anomalies, or those observations which do not seem to fit a generally accepted classification of natural phenomena. Thus, instead of attempting to average out anomalies by purely mathematical mechanics he studies the anomalies as particularly interesting phenomena in themselves.

Some thirty years ago, while VENING MEINESZ was initiating the gravity survey of Holland he encountered serious difficulty in the instability of the waterlogged terrain. The standard pendulum machine which he was using to determine local gravity (the excess or deficiency of which will serve to indicate an excess or a deficiency of mass) in the outer portion or crust of the earth was so jarred by the movements in the ground that he was forced to design an apparatus which would enable gravity to be determined in spite of these disturbances. By swinging two pendulums, instead of one, in the same plane for each observation, he discovered that he could compensate for the vibrational errors of a single pendulum. VENING MEINESZ immediately appreciated the great significance of this new geophysical as well as geodetical instrument. Like his colleague and close friend the great American geodesist, WILLIAM BOWIE of the United States Coast and Geodetic Survey, VENING MEINESZ was fully familiar with the geological implications of isostasy as originally defined by C. E. DUTTON in 1889, for the theory of gravitational balance between relatively broad, contiguous areas of different average altitudes, or of topographic relief. According to this theory continents are assumed to "stand high" relative to the ocean basins, because they are composed of lighter and less dense material. The condition of compensation, or no strain, is assumed to exist at some 60 miles below the surface of the earth, as at this depth all material must be non-rigid and capable of "flow." Hence the definition of isostasy, or the suggestion that the rigid blocks of the crust of the earth "float" in a uniform sub-crustal medium. According to isostasy the ocean basins are relatively low because the sub-oceanic lithosphere is relatively heavier (more dense) than the continents which are high because they are relatively lighter (less dense). The English Geodesist PRATT had demonstrated in his pendulum survey of India that the Himalayas were high because they were deficient in mass; and the Americans, HAYFORD and BOWIE, had published monographs on the geological, as well as the geophysical significance, of isostasy. As early as 1875 attempts had been made to determine the density of the sub-oceanic lithosphere by means of a gravity barometer, and in 1911 L. A. BAUER urged the development of an apparatus which would measure gravity at sea with the same degree of accuracy as on the *terra firma* of the continents.

Deficiency or excess in mass in any portion of the earth's crust is manifested as a gravity anomaly, and if the theoretical value for gravity, at any position, has been corrected for the topography and for isostatic compensation of the topographic features and compared with the measured value, the difference or anomaly is called an isostatic anomaly. Thus isostatic anomalies signify instrumentally determined deficiency, or excess, of mass of the crust of the earth in the immediate neighborhood of the gravity measuring machine.

VENING MEINESZ' first experiment with his multiple-pendulum apparatus was made on a small steamer on the North Sea Canal near Amsterdam. This and subsequent experiments on larger ocean-going vessels suggested that his machine could measure gravity at sea provided certain improvements were made in the mechanism such as photographic recording, gimbal-mounts and such gadgets as would tend to reduce the effect of the motion of the ship. However, he eventually discovered that the mechanical vibrations of a steam-driven vessel seriously interfered with the accuracy of his instrument. It was then that he conceived the idea of using a submarine, not only because of the possibility of obtaining greater stability beneath the surface but primarily because submarines, when operating below the surface, are driven by electric motors with a minimum, if not complete absence, of mechanical vibration. VENING MEINESZ therefore consulted the Netherlands Admiralty, and especially those officers who were particularly skilled in the operations of submarines. The purely scientific char-

acter of the problem so appealed to these naval officers that they gave full coöperation and thus helped to set a standard of naval coöperation in marine geophysics which was later followed by the American, British, French, Italian, Russian and Japanese navies.

In preparing for his first extensive submarine gravity-measuring expedition VENING MEINESZ wisely selected the outer arc of the East Indies as affording the greatest difference in altitudes (exclusive of sea level) between the tops of the mountainous islands and the contiguous foredeeps or troughs on the oceanward side of the archipelago, since these troughs were already known to be much deeper than the general level of the ocean bottom. By selecting such a geographical area for the first test of his machine he was reasonably sure that any slight inaccuracy in its operation would probably be more than compensated by the maximum difference in topography (relief) of his gravity-measuring traverse. In this respect he was entirely correct, but the gravity anomalies which he obtained were certainly not what he had expected!

The first expedition was on the Netherlands Submarine *K II* in 1923. The second expedition, on the Netherlands Submarine *K XI* in 1925. The third expedition on the Netherlands Submarine *K XIII* in 1926. The fourth expedition, on the same submarine in 1927. In the first expedition VENING MEINESZ used the same Stückrath apparatus, of four bronze pendulums swinging in two planes, that he had used in his preliminary experiments on the North Sea Canal. During the three later expeditions he used a three-pendulum apparatus, and perfected such improvements as photographic recording of each pendulum separately, multiple-chronometer readings in the timing of the pendulums, better gimbal-suspension, better pendulum bearings to decrease friction, and other details in design which not only increased the accuracy of the entire apparatus but also its ease of operation. Between 1923 and 1927 after much hard labor, and with the full coöperation of the Netherlands Navy, VENING MEINESZ had definitely proved the accuracy of what we may now designate the Vening Meinesz Marine Gravimeter; but, this assurance of the dependability of his apparatus made the gravity anomalies which he had obtained all the more astounding. He discovered greater gravity anomalies, regardless of sign, than had hitherto been found for any part of the earth's crust, or lithosphere. More astonishing still this relatively narrow line of anomalies, closely following the foredeeps or troughs on the oceanward side of the great sinuous island archipelago, proved to be a well-defined strip of negative anomalies! As VENING MEINESZ had expected, the general gravity field of the sub-oceanic lithosphere was slightly plus, intimating a greater density than that of the continents. Why, therefore, did these great foredeeps which occurred as major depressions in the sub-oceanic lithosphere register a greater deficiency in density than the highest mountains on the continents? Could it be that this astounding negative anomaly strip which we now refer to as the Vening Meinesz Strip, was a direct refutation, in such oceanic regions, of the great principal of isostasy? Thus by 1927 VENING MEINESZ had discovered one of the apparently greatest anomalies in the whole of geoscience, but an extremely dynamic anomaly which, like geomagnetism, makes no direct and measurable impression on our senses, but is as fully important in geoscience as earthquakes and volcanoes whose superficial phenomena we now suspect may be closely related, in origin, with his discovery of the negative anomaly strip in the Netherlands East Indies.

WILLIAM BOWIE had followed the discoveries of VENING MEINESZ with increasing interest. Although the leading authority of the geophysical implications of isostasy he was neither disturbed nor dismayed at what, at first, appeared to be a serious blow to isostasy. Anxious as always to expand gravity surveys, both on land and at sea, BOWIE urged the collaboration of the United States Navy with VENING MEINESZ for the geophysical exploration of the Gulf of Mexico and those portions of the Caribbean Sea which were internationally open waters. BOWIE aroused the interest of Captain C. S. FREEMAN, Superintendant of the United States Naval Observatory, and eventually VENING MEINESZ was invited to continue his explorations in the Gulf-Caribbean Region with the further encouragement and coöperation of the National Academy of Sciences and the Carnegie Institution of Washington. This expedition was made during the fall of 1928 with the United States Submarine *S-21*. VENING MEINESZ was accompanied by F. E. WRIGHT of the Carnegie Institution of Washington, and E. B. COLLINS of the Hydrographic Office of the United States Navy. This expedition produced some noteworthy results, such as: (1) The suggestion that the Mississippi Delta is in isostatic equilibrium; (2) deficiency in gravity parallels the submerged margin of the continental shelf. However, the plan of the expedition seems to have been rather to test certain suboceanic areas as to the theory of isostasy rather than to determine whether or not the West Indian Archipelago was geophysically as well as geographically a counterpart of the East Indian Archipelago. In both the American and the previous Netherlands expeditions VENING MEINESZ had the advantage of the recently perfected sonic-sounding method for determining suboceanic topography, although full use of this rapid and accurate technique, so essential in the computation of gravity anomalies, was not fully developed until 1932. In 1929 VENING MEINESZ made another gravity measuring cruise to the East Indies in the Netherlands Submarine *K XIII*, and marine gravimetry had now become a "fashionable" adjunct to oceanographic exploration.

The Russian Navy made a gravity survey of the Black Sea in 1930 and the Italian Navy a gravity survey of the Mediterranean in 1931. Also, in 1931, gravity determinations were made with the Vening Meinesz apparatus in the Arctic Ocean during the *Nautilus* Expedition. It was not until 1932, however, that any serious attempt was made to prove the full geological as well as the geophysical significance of the strip of negative gravity anomalies associated with the East Indies archipelago. It had naturally taken several years for the leading structural geologists of the world to begin to appreciate the possible significance of VENING MEINESZ' geophysical discovery as directly related to tectonophysics, or the application of geophysical methods and techniques to exploration and study of mountain building and the accompanying phenomena of volcanoes and earthquakes. During his explorations in the Bahamas (1927) R. M. FIELD had discussed with WILLIAM BOWIE the use of a gravity

survey of the islands to determine whether or not the coral reefs and associated carbonate sediments were underlain by volcanic rocks of greater density. With the coöperation of the United States Coast and Geodetic Survey a gravity survey was made in the Bahama Region. This survey definitely proved that the Bahama Islands were not extinct volcanoes capped with coral reefs and that their geomorphology could not be explained in that way. It was further proved that the whole Bahama Region was structurally in no way related to the West Indian Archipelago, and it remained to be discovered as to what part Cuba played in the geological history of the Gulf-Caribbean Region. BOWIE then urged a marine gravity survey in the deep waters between the islands, and VENING MEINESZ consented to make such a survey provided it could be organized with the essential coöperation of either the Netherlands, British or American Navies. In December 1932 VENING MEINESZ attended the annual meeting of the Geological Society of America held in Tulsa, Oklahoma. It was at this meeting that he first thoroughly aroused the interest of the leading structural geologists in the United States and, in particular, conferred with B. WILLIS, A. C. LAWSON, W. H. BUCHER, W. T. THOM, and several petroleum geologists who were international pioneers in the development of geophysical-geological techniques. With the coöperation of the British Government, the United States Navy, the United States Coast and Geodetic Survey, the Geological Society of America, the American Geophysical Union, and the Department of Geology, Princeton University, the United States Navy-Princeton Expedition to the West Indies had already been organized. On this expedition VENING MEINESZ had the use of the United States Submarine *S-48* and the Submarine Tender *Chewink* which made the bathymetric soundings with the most modern equipment, so essential to the suboceanic gravity surveys. While VENING MEINESZ was determining the suboceanic gravity anomalies, the gravity survey on the islands was continued with the coöperation of the United States Coast and Geodetic Survey and several private agencies. VENING MEINESZ was assisted by T. C. BROWN of the United States Naval Research Laboratories and a young geologist from Princeton, H. H. HESS, who has since become one of the leading authorities on the tectonophysics of island arcs.

Later in the same year VENING MEINESZ made a gravity survey of the Mid-Atlantic Ridge near the Azores, in the Netherlands Submarine *K XIII*. M. MATUYAMA made a gravity survey of the Nippon foredeep with a Vening Meinesz apparatus on board the Imperial Japanese Submarine *RO-57*, and P. MARTINI made a gravity survey of the northeast Mediterranean with a Vening Meinesz apparatus on board the Italian Submarine *Fresnel*. In 1934 VENING MEINESZ made a gravity survey in the Netherlands Submarine *K XVIII* from Holland to Brazil to Capetown to Australia to Java; MATUYAMA made a gravity survey of the Japan Deep; and G. CASSINIS in 1935 further explored the Mediterranean, in the Italian Submarine *Des Geneys*.

In 1936, as Chairman of the Committee on the Geophysical and Geological Study of Ocean Basins of the American Geophysical Union, R. M. FIELD organized the United States Navy-American Geophysical Union Expedition to the West Indies, with the coöperation of the United States Navy, the United States Coast and Geodetic Survey, the Geological Society of America, the American Bell Telephone Laboratories, the Woods Hole Oceanographic Institution, and the American Philosophical Society. HESS was on this expedition as geological expert and M. EWING of Lehigh University was in charge of the gravimetric survey, assisted by R. J. HOSKINSON of the United States Coast and Geodetic Survey. The gravity cruise was made in the United States Navy Submarine *Barracuda*. EWING had succeeded in making some further improvements in the Vening Meinesz apparatus — notably in the mechanical timing of the pendulums. It was this expedition that definitely proved that the West Indian Arc was tectonophysically similar to the East Indian Arc, and that the Vening Meinesz strip of negative gravity anomalies was one of the greatest phenomena in the deformation of the lithosphere. The theory of isostasy had not been disproved — in fact it had been somewhat strengthened — but a new mechanism had been discovered in mountain building which had introduced an entirely new concept in structural geology. At present the Vening Meinesz negative gravity-anomaly strip as peculiarly associated with island arcs is interpreted by VENING MEINESZ and P. H. KUENEN (Netherlands), H. H. HESS, W. H. HOBBS, B. WILLIS, W. H. BUCHER, R. A. DALY and R. M. FIELD (U.S.A.), E. B. BAILEY and O. T. JONES (England), L. W. COLLET (Switzerland), and others in the following manner:

(1) A strongly negative gravity-anomaly belt, or strip, coincides with the outer, convex side of island arcs such as the Netherlands East Indies and the West Indies. The width of the negative gravity-anomaly strip is approximately less than 50 km wide. In the East Indies the strip is 5,000 miles long, and in the West Indies it is well defined along the entire arc from the eastern end of Cuba to the Coast of South America. The order of magnitude of the gravity anomalies within the area of the negative strip is from −150 to −200 milligals, and there can be no doubt that the area of the negative gravity-anomaly strip signifies an abnormal, local deficiency in density for the entire thickness of the lithosphere for that area — certainly a local, but exceedingly important departure from isostatic equilibrium.

VENING MEINESZ and his countryman, KUENEN, were the first to recognize the great geological significance of this discovery and, together with HESS, suggested not only the cause of the phenomena in terms of structural geology, but also the consequent relation of volcanic activity and the origin of igneous rocks, including the very significant and concomitant belts of serpentinized peridotite intrusions. Others, notably N. H. HECK, have discussed the significant relation of VENING MEINESZ' discoveries to the phenomena and origin of earthquakes.

The outer crust of the earth, or lithosphere, is known to have a specific gravity, or density, of approximately 2.7. This lithosphere has been shown by the seismologists to have a thickness of 25–35 km with an underlayer of the same thickness having a specific gravity or density of approximately 3.0. Beneath the layer of density 3.0 occurs a third layer of density 3.3. The outer layer of density 2.7 therefore characterizes the lithosphere to the depth of isostatic compensation. This is frequently, though incorrectly, spoken of as the granitic layer because the mean

average chemical composition and density of all types of rocks which compose the lithosphere is approximately that of the chemical composition and density of the igneous rock granite. The immediately underlying couch or stratum of denser material, because of high temperature and pressure, has no rigidity and exists as a magma which, when it finds its way into the lithosphere, cools and solidifies as an igneous rock called basalt. The subbasaltic layer or couch is composed of an even denser magma (sp. gr. 3.3) which when injected into the lithosphere solidifies to form the ultra-basic igneous rock known as peridotite. It should be particularly noted that the increase in difference in density downward from the granitic to the basaltic to the peridotitic layer is 0.3. VENING MEINESZ and KUENEN, realizing that the thickness of the granitic and the basaltic layers was approximately the same, suggested that within the area of the pronounced negative gravity-anomaly strip the granitic layer had entirely displaced the basaltic layer, thereby becoming 50–70 km thick, or twice the normal thickness of the lithosphere; and that island arcs, such as the East Indies and the West Indies, are long narrow structural belts where the lithosphere is close to, if not in direct contact, with the peridotitic layer. VENING MEINESZ further suggests that the peculiarly localized displacement of the basaltic layer by the lithosphere is due to a great compressional downfold of the lithosphere; and KUENEN further strengthens this theory by laboratory experiments in which he was careful to adapt the strength of the materials to the scale of his model. Thus was born the concept of the Tectogene, or downfold of the entire lithosphere, which since 1933 has played, and will continue to play, an important part in all observations and theories regarding the structure and origin of mountains.

One hundred and two years ago the ROGERS brothers described the structure of the Appalachian Mountains of Pennsylvania as a relatively narrow but thick belt (20,000 feet) of marine and estuarine sedimentary rocks which had been folded, faulted, uplifted, and eroded so as to produce the mountains which we see today.

In 1873 J. D. DANA suggested that the thick accumulation of sediments filled a long, narrow trough as it was being formed by lateral compression of the lithosphere. He also suggested that, after the trough had been filled with thousands of feet of sediments, its further compression squeezed the sedimentary filling into the great series of folds whose uplifted and eroded remnants form the present ridges and valleys of Pennsylvania. Such great compressional troughs he called geosynclines, and the folded filling of the troughs, synclinoria. The geosynclinal theory, originating from the study of the Appalachian Mountains, has been found to be applicable to the North West Highlands of Scotland, to the Swiss Alps, and to other regions where the stratigraphy and structure of the deformed rocks had been sufficiently studied. The geophysical studies in the Netherlands East Indies and the consequent leadership of VENING MEINESZ in the geophysical study of the West Indies suggests that the foredeeps in front of these great island arcs represent geosynclines in the making, but these geosynclines were not filled with sediments because of the lack of source material from the narrow bordering strip of islands (geanticline). Thus, the great curved linear geosynclinal belt, or anticlinoria of the Carpathians, Alps and Apennines is remarkably similar in origin to the embryonic development of the present-day island arcs. VENING MEINESZ and KUENEN have suggested the Tectogene, as the father of geosynclines, and their accompanying thick belts of deformed eroded sedimentary rocks and igneous intrusions.

Such has been the scientific contribution of Holland, through VENING MEINESZ and the Netherlands East Indies, to the whole of geoscience.

In their introduction to "The Contribution of Holland to the Sciences" (1943), A. J. BARNOUW and B. LANDHEER make the following observations: "The history of his own special field of knowledge is a field to which few scientists pay attention . . . In times like ours it is of significance to see how the combined efforts of many people have led to the discoveries or innovations which we so easily ascribe to one person. . . . That the Netherlands has always pursued a policy of tolerance has been an essential factor in the development of its scientific achievements." We have tried to emphasize the effect which VENING MEINESZ, the Netherlander, has had on geoscience. What has been the effect of geoscience on VENING MEINESZ, the Netherlander?

The last time that VENING MEINESZ was able to mix freely with his international colleagues was in September, 1939, during the Seventh General Assembly of the International Union of Geodesy and Geophysics in Washington, D.C. For several weeks, previous to this Assembly, events in Western Europe had rapidly become more disturbing. Delegates from most of the adhering countries, then thirty-two in number and including all of the present belligerents, arrived in fair numbers, but there was some discussion as to the advisability of cancelling the Assembly. Finally, just previous to the meeting, Germany invaded Poland, and there was a hurried meeting of the Bureau of the Union which determined to carry on. In this discussion the Bureau was greatly encouraged by the United States Department of State, whose Secretary, CORDELL HULL, opened the Assembly with these words: "It is my fervent hope, which the people of this country share, that the day may soon come when the statesmen of the world will take a leaf from the book of the scientists and solve international political problems in the same dignified and friendly spirit."

During the succeeding week of the Assembly VENING MEINESZ was a tower of strength. No one foresaw more clearly than he the consequence of Germany's invasion of Poland, yet his tolerance during this international gathering of scientists in Washington was largely responsible for the calm and friendly spirit of its deliberations. As President of the International Association of Geodesy, his were the primary interests of a great specialist whose scientific inclinations were to emphasize the international importance of geodesy. However, his researches in the Netherlands East Indies, extending to all the oceans and continents of the earth, had taught him the importance of coöperation not only of different specialists, but also of all manner of men. Above all, he had made the most of the full social opportunities of fundamental geoscience, in contradistinction to the somewhat asocial implications of mathematics and astronomy or the economic implications of physics and chemistry. He, particularly, was trusted by every one — Poles, Germans, Italians, Japanese, and British alike. Ac-

cording to last accounts VENING MEINESZ is still in Holland. We are not informed as to his present physical or mental condition, but we sincerely hope, that in the interests of post-war planning he will be able to help us. Any scientist who has accomplished so much in international coöperation without the destructive stimulus of war will be particularly needed during the post-war period of reconstruction. VENING MEINESZ is such a scientist; to his more intimate colleagues he is still a typical Hollander and a famous explorer of the structure and origin of the Netherlands East Indies. His hypothesis of the Tectogene will undoubtedly be modified, and may even be replaced, but his discovery of the negative gravity-anomaly strip will remain as the greatest advance in the application of gravitational physics to geology since the discovery of the deflection of the vertical, and the consequent geophysical-geological concept of isostasy.

A few of the most significant branches of geoscience which are particularly affected by the first discovery of the negative anomaly strip in the East Indian Archipelago are:

(1) Theory and origin of geosynclines
(2) Location and origin of earthquakes
(3) Origin of volcanoes
(4) Origin of ultra-basic eruptives and serpentines
(5) Direction and rate of migration of geographic coordinates
(6) Depth of isostatic compensation
(7) Permanency of ocean basins
(8) Numerous problems in stratigraphy and structural geology
(9) Origin and distribution of geomagnetism.

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# THROUGH BANTAM AND THE PREANGER REGENCIES IN THE EIGHTIES

*by*

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On the road — The Sundanese language — Every man a naturalist — Bird-life at Genteng — Weaver-birds' nests — A native rural bazaar — Forest devastation — Geological structure of the district — A wonderful case of mimicry in a spider.

On my return to Java from the Keeling Islands, I had the good fortune to meet in Batavia with a countryman, Mr. ALEXANDER FRASER, one of the few freeholders of land in Java, who though just starting for England, kindly offered me the privilege of collecting over his vast property situated in the western province of Bantam, and the hospitality of his house if I should choose to stay there. This offer I was only too pleased to accept, in order, while still within reach of civilisation, to become acquainted with, and gain some practical experience of, the necessities and modes of tropical life and camping, of which the novitiate traveller has such crude ideas — for collecting among tropical vegetation is very different from the ideas formed of it from like operations conducted amidst the sparse woods of our temperate climate; — but principally to isolate myself from all European-speaking people for the purpose of acquiring, with the aid of a few books and chiefly with my native servants, the Malay language as rapidly as possible. In addition, the late Dr. SCHEFFER, the kind Director of the Botanical Gardens in Buitenzorg, had recommended to me Bantam as a profitable and by no means, botanically at least, well investigated province to visit.

Having hired a couple of cahars — a sort of spring-cart with one horse, the general mode of conveyance when one travels as I was about to do, off the main roads — one for myself and one for my baggage, I left Batavia at sunrise on the 12th of March [1879], by the western road along the low northern shore lands towards Rangkasbetong, by the famous highway which DAENDELS, one of the most energetic and far-seeing of all the early Governors-General of the Dutch Indies, constructed along the whole length of the island, and which has proved one of its greatest benefits and colonizers. To expedite the journeys of their various officials round their districts, at every five or six miles stable stations have been erected by the Government, where horses are changed, and which private travellers can obtain permission to make use of on payment of small mileage dues.

All along the road we passed little sign-posts with Arabic inscriptions indicating how many yards of the road on each side of them must be kept in repair by the various neighbouring villages. As the keeping of the roads is most strenuously enforced, they are never out of condition, and are a pleasure to drive over. Here and there it has been impossible to bridge the larger rivers in steep defiles where the stream is deep and swift, and these are crossed in large picturesque rafts which can accommodate horse and carriage and quite a little crowd of people at once. These rafts, by sliding on rattan rings along two strong cables of thick rattan canes securely fixed to

* Reprinted from the author's "A Naturalist's Wanderings in the Eastern Archipelago, A Narrative of Travel and Exploration from 1878 to 1883" (pp. 51-117 (*p.p. maj.*), 1885).

both banks, are floated over by the ferrymen by hand-over-hand traction on these cables.

When on the road the dress of the Sundanese, especially of the women and children, is invariably bright coloured calicoes, clean and newly ironed, and their head-covering is the gaily lacquered bamboo hats for whose manufacture they are famous. The burdens of the men, whatever they may consist of, are made up in neat and tastefully arranged bundles, carried always on the shoulders, suspended at the ends of a bamboo — and it is amazing what a weight these thick-set stout fellows can carry in this way. Such a ferry, in the sunlight, with a background of green, wooded slopes, presents therefore always a gay scene and forms quite an interesting break in the drive.

The country throughout was rather tame, being quite stripped of forest, but full of interest, as the land, being entirely under rice cultivation, was laid out in the most beautiful system of terraces. The province of Bantam is densely populated, and scarcely a portion of uncultivated land was to be observed. As Mr. WALLACE in his "Malay Archipelago," has fully described, this method, introduced by the Hindus on their invasion of Java, has attained a wonderful development throughout the whole of the lowlands in the western part of the island. In these *sawahs*, as the natives call their wet rice fields, the grain is cultivated in small square borders separated by green, grass-ridged banks, kept constantly flooded with water brought by a wonderful network of channels in which an intricate system of sluices or valves distributes or cuts off its flow wherever desired. The entire face of such low hills as have a gentle slope, are thus laid out down to their bases, and at the season when the young corn is in its fresh green leaf the country is extremely pretty.

Mr. FRASER's estate-house at Tjikandi-Udik, which I reached late in the evening, I found to stand amid a rich and entirely cultivated country, but as regards my pursuits a barren territory. After enjoying for a few days the hospitality of the Administrator I moved south-westward to Genteng in the higher region of Lebak, where I was told some forest was then being felled.

Here I built a bamboo-hut in an open spot with an exhilarating look-out on the high mountains, and alone with my Malay boys began my initiation into the language of the country, and into the nomadic joyous life of a field naturalist. It is a life full of tiresome shifts, discomforts, and short commons; but these are completely forgotten, and the days seem never long enough amid that constant flash of delighted surprise that accompanies the beholding for the first time of beast or bird or thing unknown before, and the throb of pleasure experienced, as each new morsel of knowledge amalgamates with one's self.

Between myself and my boys for a time the most ludicrously comprehended sign-language was carried on, till their speech, whose sentences to my unaccustomed ears seemed composed of but one continuous word of innumerable uncouth syllables, began to shape itself into distinguishable elements, when to my amazement, as if some obstruction had been suddenly removed from my ears, I comprehended them as if I had been brought up among them. Before many weeks were over I could converse in the Malay tongue with an amount of freedom that surprised me.

The language of the district, that is, of the Sundanese themselves, though containing many Javanese and Malay words, is quite distinct from either. It is a coarser and rougher speech, and it was some time before I managed to acquire it; but I found it to be — like broad Scotch in comparison with pure English — one of great expressiveness.

As soon as I was able to follow their discourse with ease, my daily talks with these men were a source of great pleasure to me. I soon found out that in regard to every thing around them, they were marvellously observant and intelligent. Not one or two only, but every individual amongst them seemed equally stored with natural history information. There was not a single tree or plant or minute shrub, but they had a name for, and could tell the full history of; and not a note in the forest but they knew from what throat it proceeded. Every animal had a designation, not a mere meaningless designation, but a truly binomial appellation as fixed and distinctive as in our own system, differing only in the fact that their's was in their own and not in a foreign language. Often enough this designation has so close a resemblance and sound to Latin, that it has been accepted by Western naturalists as if it had been so. One of the liveliest and most obtrusive of the squirrels in Java and Sumatra is a little red-furred creature called by the natives *tupai*, and to distinguish it from its more arboreal congeners they add, from its habit of frequenting branches near the ground, the word *tana* (for earth); and *Tupaia tana* is its accepted scientific term among European naturalists.

They have unconsciously classified the various allied groups into large comprehensive genera, in a way that shows an accuracy of observation that is astonishing from this dull-looking race. In this respect they excel far and away the rural population of our own country, among whom without exaggeration scarcely one man in a hundred is able to name one tree from another, or describe the colour of its flower or fruit, far less to name a tree from a portion indiscriminately shown him. How acute is their observation is exemplified by their name for the groups of true parasitic plants of the *Loranthaceæ* (or Misletoes), which are disseminated chiefly by being unobtrusively dropped by birds in convenient clefts of trees, they denominate as *Tai booroong* ("birds' excreta"); while to epiphytic plants they give a name that has almost the significance of our own scientific term. The great group of the Laurels, which so vary in flower and foliage as to be separated off into many genera by botanists, are all designated by the one name *Huru*, but they are differentiated by no fewer than sixty-three different specific terms, in every instance indicating some prominent distinguishing characteristic of flower, fruit or timber; and on examination, very few indeed of them turn out not to belong to the Laurel family. Of oaks, *Passang* in their tongue, they discriminate sixteen different species, commencing their list with the one they consider most typical, just as we find in our own catalogues of birds, among the Warblers for instance, *Cisticola cisticola* representing the typical species, the Sundanese say *Passang betūl*, or "true oak," for what they consider the oak of oaks. Among animals their system of classification into genera is not carried so far; but all the more distinctive groups, especially those living in communities, and every in-

sect and bird, if in any way peculiar or where it can be mistaken for another, have each their own binomial appellation.

I was disappointed in finding that the forest about Genteng was nearly all second growth, with scarcely any of what I was principally in search of for my herbarium — specimens of the primal trees. Birds, however, were more plentiful, and in the avenue-like roads and paths, stretching for miles in the neighbourhood, butterflies and other insects were very abundant, but though interesting to me, and occasionally new to the ornithology or entomology of the Malayan region, most of them were species well known to science. Amid an expanse of low scrub in front of my door, on which the buffaloes from the neighbouring villages wandered more at their own will than directed by their young herds, stood within gunshot of my verandah table several tall trees, from which, frequented as they were at all hours of the day by different kinds of birds, I was constantly able to add with great ease to my collection, and to observe the habits of many species that it would have been difficult otherwise to see.

I never tired of watching the friendly relation between the Buffalo-birds (*Sturnopastor jalla* and *S. melanopterus*) and their bovine hosts. They used to collect in impatient flocks about the hour of the return of the herd to their feeding grounds from the wallowing holes, whither in the heat of the day they retired; and as soon as the cattle arrived they would alight on their backs in crowds, to the evident satisfaction of the oxen, which they relieved of troublesome parasites. Although the herd-boys commonly lay dozing at full length on the buffaloes' backs, the birds seemed to know that they were quite safe, and would even alight on the bare backs of the sleepers, and from that hop on to the haunches of the quadruped; and when the herds were driven away at nightfall the Sturnopastors flew off to the forest.

One of the rarer birds obtained here was the fine red-crested Woodpecker (*Miglyptes tristis*), which much resembles the *M. grammithorax* of MALHERBE, which is not found in Java, while the former, distinguished by its uniform black breast and abdomen, is confined to this island.[1] In the gloaming, frequenting leafless branches, I often saw the minute Butterfly Hawk (*Microhierax fringillarius*), not so large as a shrike, darting after grasshoppers, moths and late-flying butterflies. Among the songsters that made themselves more noticeable by frequenting the isolated trees near my house, were the golden Oriole (*Oriolus maculatus*) and the yellow crowned Bulbul (*Trachycomus ochrocephalus*), which late in the evenings filled the whole neighbourhood with their melodious, clear, bell-like notes; while two members of the Cuckoo family, the "Doodoot" (*Rhinococcyx curvirostris*) and the "Böot" (*R. javanensis*) used to utter their curious bleating call in the low jungle behind, often breaking with their weird modulations the stillness of the midnight. In a neighbouring clump of canes a colony of Yellow Weaver-birds (*Ploceus hypoxanthus*) had thickly hung their nests. Each nest was artfully suspended between the interlacing leaf-stems of one or two reeds in a most skilful way, to secure as much as possible the safety of their eggs during the waving of the reeds in the wind. These nests were not made fast to, but strung lightly on the leaves, sometimes passed through the fork of another leaf to form a pulley, so as to permit, by sliding along in the swaying of the grass, of their retaining their vertical position, which they must do, weighted as they are by a layer of clay in the bottom of the nests. I noticed that many of them were deserted from the breaking of one or more of their eggs, after incubation had progressed some way; in others, where there was only one chick, there was often one egg which had been cracked and become dried up, so that even with all their acute architectural devices the wind appears to wreck the hopes of the little builders.

What can be the use of the mud in the Weaver-birds' nests has often been discussed. Mr. E. L. LAYARD, the accurate observer and well-known ornithologist, has suggested[2] "that these lumps of mud were used as scrapers on which to clean the birds' bills"; but if in the nests I found here they were used for this purpose, it must have been only at the commencement of their task, for the layer of mud would be quite concealed at an early stage of their nest-building. I am more inclined to the belief that they are to weight and balance the nest, from having found loose among the lower stems unfinished portions, which were evidently the foundations of nests, which had been blown down before being properly secured, or were they, perhaps, abandoned unsuccessful first attempts? They had the exact shape of tiny key baskets, such as are used by housewives, one end being weighted with a layer of clay. I was also struck by the fact that different individuals had adopted different forms of nests, which, though agreeing fundamentally, exhibited considerable variation. The bulk of them were of the retort shape, set with a long-necked orifice hanging downward, but a considerable number, of the progressionist party perhaps, had inaugurated a new fashion by inverting the retort and shortening the neck, giving the doorway an upward and forward entrance, which, if more enticing to depredators, may perhaps be less awkward to the owners. I much regret that I have no note as to the position of the clay in this new form; for what was previously the bottom of the nest had become a dome over the bird, while its eggs were laid in what would correspond in the older pattern with the upper curve of the neck of the retort, so that if my belief is correct that the use of the clay is to retain the nest in its vertical position, it ought to be found occupying a corresponding site in the new structure. It is possible, however, that the deviation from the ancestral pattern may result from an unequal distribution of clay during the laying of the foundation of the nest, causing it to become reversed without diverting the bird's purpose from completing its work as best it could, under the altered conditions.

One of the bird-cries that early attract attention is the reiterated, unvaried call of the Bell-birds (*Megalæminæ*), poured forth in long stretches from the top of some high tree, where, from their plumage according so well with the varied colours of the vegetation, they can select a perch even in a prominent branch without fear of discovery. I obtained five different species of these birds, which belong to one of the most

[1] *Cf.* HARGITT, 'Ibis,' 1884, pp. 190, 191; and NICHOLSON, *op. cit.*, 1879, 16.

[2] *Nature*, Dec. 1879.

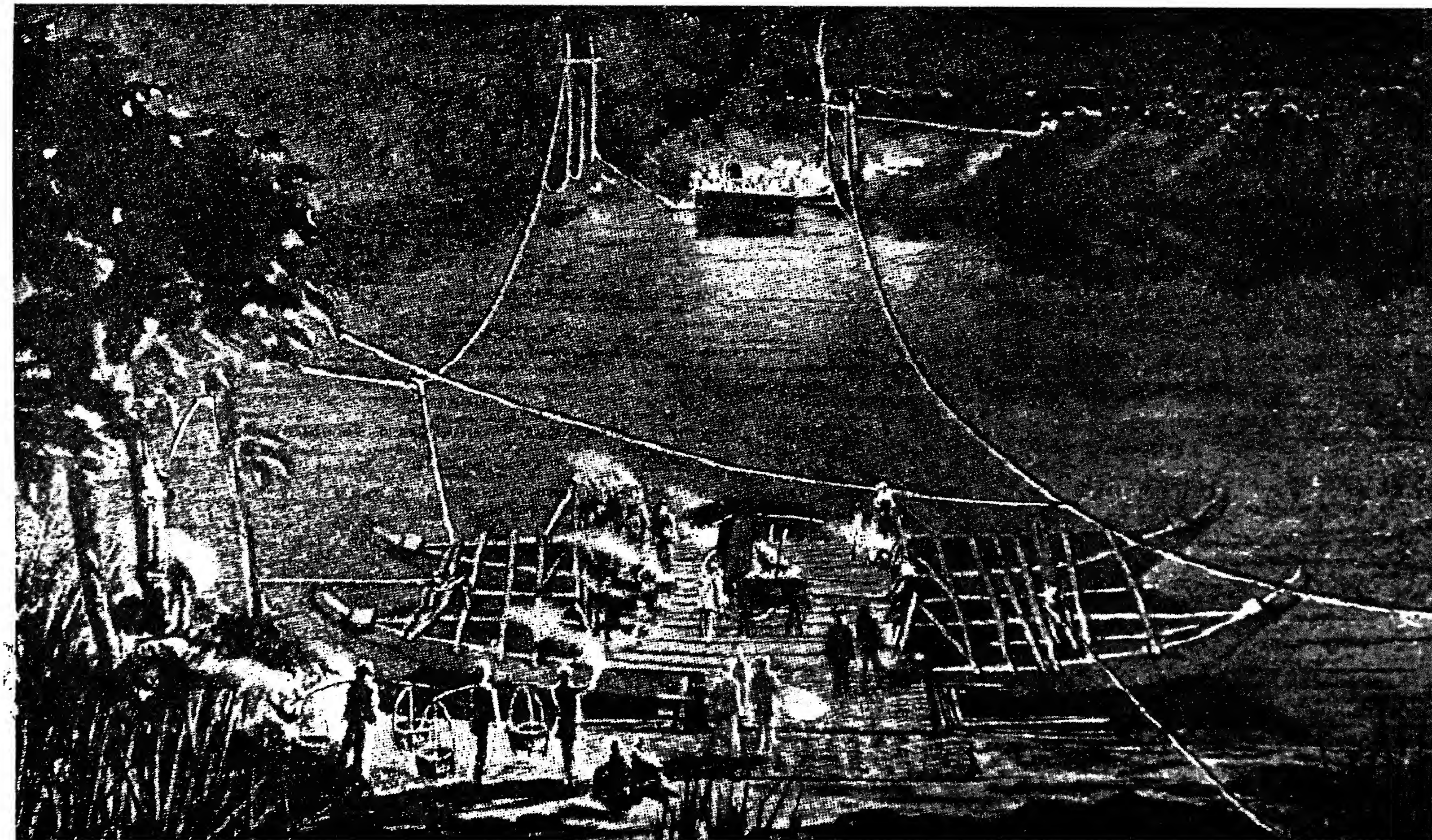

FIGURE 26. — A NIGHT CROSSING OF THE TJITARUM RIVER IN WEST JAVA. — *After an old print.*

varied and beautiful-plumaged families, and of which some idea may be obtained by turning over the pages of MARSHALL's splendid monograph of the group.

A stream which ran near my house was crossed by one of those native-made bamboo bridges, which spaciously housed and thatched over, have such a neat and attractive look about them. Every Sunday morning the district market was held under it, which from an early hour presented quite a gay and busy scene. I never missed, if I could, an opportunity of visiting these *Passars*, as I found them delightful resorts for studying the native in his gayer moods; for market-day was always their holiday, and the market-place the rendezvous for the youths and maidens of the district, as well as the news-exchange of the old men. The vendors, to be early at the market-place, generally spent Saturday evening and night under the shade of the bridge, or collected in the neighbouring village, whence the tinkle of the gamelang, their characteristic musical instrument, would be heard throughout the livelong night in company, if not concord, with the higher notes of their curiously drawling voices, repeating tjeritas or semi-historical tales, and adaptations from the Korān, varied by *pantūns* or love songs.

The collection of wares exposed for barter was always a curious one: *sarongs* from their own looms — whose incessant click-clack is one of the most pleasant and characteristic of the industrial sounds in their villages — calicoes and silk kerchiefs from Manchester and Liverpool; CLARK's Paisley thread of "extra quality"; native-made horn combs, gay ornaments of spangles and beads, and the elaborate inlaid silver breast-pins for which the district is famous, worn by every female to fasten her loose upper robes; and bamboo hats in great variety. The Bantamese are specially noted for the manufacture of these last, and some of them are really exquisite specimens of plaiting. In the finest quality, made of carefully prepared narrow strips of the wood, a quiet but lucrative trade is done with European markets by unobtrusive go-betweens who collect them through the district. In Bantam they cost a mere trifle, but in Paris, I am informed, they are retailed at a profit of nearly one thousand per cent., as true Panama hats, from which it is difficult to distinguish them. One of these hats, that I treated to the roughest jungle work of three years, was scarcely impaired when we parted company.

Other than these the chief articles were household utensils, large copper jars for the preparation of rice, beat out of sheet copper by native smiths, and shallow iron basins (of Singapore make) for the daily extraction of the oil of the cocoa-nut palm, without which and its twin brother the bamboo, native prosperity and happiness would cease. There were besides piles of various species of dry-salted river fishes, chiefly Gabūs (*Ophiocephalus striatus*), Soro and Regis (*Barbus duronensis* and *B. emarginatus*), and Guramè (*Ophromenus olfax*), the most prized of them all, in which a large and profitable trade is carried on with distant parts of the Archipelago. Many of these fishes are carefully preserved in the larger wet rice fields, where during the rainy season, having abundance of food, they multiply with great rapidity. During the hot season, when the *sawahs* have become, except in the centre, dry fields, the fishes are captured in immense numbers. Fried in fresh oil they form an excellent dish, and are the staple flesh-food of the natives.

A vile odour which permeates the whole air within a wide area of the market-place, is apt to be attributed to these piles of fish; but it really proceeds from another compound sold in round black balls, called *trassi*. My acquaintance with it was among my earliest experiences of housekeeping at Genteng. Having got up rather late one Sunday morning — an opportunity taken by one of my boys to go unknown to me to the market, which I had not then visited — I was discomfited by the terrific and unwonted odour of decomposition: — "My birds have begun to stink, confound it!" I exclaimed to myself. Hastily fetching down the box in which they were stored, I minutely examined and sniffed over every skin, giving myself in the process inflammation of the nostrils and eyes for a week after, from the amount of arsenical soap I inhaled; but all of them seemed in perfect condition. In the neighbouring jungle, though I diligently searched half the morning, I could find no dead carcase, and nothing in the "kitchen-midden," where somehow I seemed nearer the source; but at last in the kitchen itself I ran it to ground in a compact parcel done up in a banana leaf.

"What on the face of creation is this?" I said to the cook, touching it gingerly.

"Oh! master, that is trassi."

"Trassi? What is *trassi*, in the name of goodness!"

"Good for eating, master; — in stew."

"Have *I* been eating it?"

"Certainly, master; it is *most* excellent (*enak sekali*)."

"You born fool! Do you wish to poison me and to die yourself?"

"May I have a goitre (*daik gondok*), master, but is *is* excellent!" he asseverated, taking hold of the foreskin of his throat, by the same token that a countryman at home would swear, "*As sure's Death!*"

Notwithstanding these vehement assurances, I made it disappear in the depths of the jungle, to the horror of the boy, who looked wistfully after it, and would have fetched it back, had I not threatened him with the direst penalties if I discovered any such putridity in my house again. I had then to learn that in every dish, native or European, that I had eaten since my arrival in the East, this Extract of Decomposition was mixed as a spice, and it would have been difficult to convince myself that I would come by-and-bye knowingly to eat it daily without the slightest abhorrence. DAMPIER, who mentions it in his "Voyage," seems to have formed his acquaintance with it in a more philosophic spirit, for he describes it in these terms: — "As a composition of a strong savour, yet a very delightsom dish to the natives. To make it they throw a mixture of shrimps and small fish into a sort of weak pickle made with salt and water, and put into a tight earthen vessel. The pickle being thus weak, it keeps not the fish firm and hard, neither is it probably so designed, for the fish are never gutted. Therefore in a short time they turn all to a mash in the vessel; and when they have lain thus a good while so that the fish is reduced to pulp, they then draw off the liquor into fresh jars and preserve it for use. The masht fish that remains behind is called Trassi. 'Tis rank scented; yet the taste is not altogether unpleas-

ant, but rather savoury after one is a little used to it."

One of the most terrible scourges of the island, and for which no remedy seems possible, is the spread everywhere of a species of tall, slender cane — useless for fodder and good only for thatch, — which the natives call alang-alang. Every spot unoccupied by forest, falls a prey to it; and when once it gets the upper hand, forest seeds refuse to root in it. Neither the incessant rains, nor the driest droughts of summer kill it. The fire may sweep the surface bare, but it fails to touch the roots, which spring again in fresher vigour through the ashes. Deep shade alone seems to check its growth. The native in the hill regions does not make *sawahs* (which are good from year to year), but constantly takes in his fields by felling, where he lists, in the unbroken forest. As, after reaping for only two seasons this new land, (on which he scatters his seed between the fallen trunks), he deserts it for a newer patch, broad tracts of the island are every year becoming covered with this ineradicable exhauster of the soil, and by-and-bye the virgin forests of this country will have entirely ceased, if some sharper supervision be not exercised by the Government over the timber-felling mania of the native. As Colonel BEDDOME remarks of the like devastation in India: "the value of the timber thus destroyed by one man, calculating it by the number of logs it might have yielded, is at least twenty times as great as the value of the crop of *ragi* obtained in the two years that cultivation is continued. The low jungle which comes up after desertion of *kumari* land is more injurious to health than lofty forest open below. Besides health considerations and decrease of rain and moisture, this rude system of culture [results in] the destruction of valuable timber . . . and rendering of land unfit for coffee."

The present vegetation of the whole of this portion of the island stands on an unbroken layer of volcanic mud, which tells of a period of almost unparalleled volcanic activity. Wherever the streams have opened sections, or a road cutting has been made, numbers of great trees, some of them thirty yards in length, are exposed in a completely silicified condition, and often so perfectly as to have preserved to their cores the structure of their tissues. Standing on some one of these bare denuding slopes, I have tried to picture to myself the terrible outburst in which this region must have been overwhelmed, at a date which cannot geologically have been very remote; for lying prostrate in great numbers as they were, — many of them having fallen across each other, — the forest of which they formed a part must have been suddenly entombed beneath an avalanche of the petrifying mud so deep that the powerfully corroding tropical rains of centuries are only now beginning to exhume them.

About the only piece of exposed strata in this part of Java, I believe, lay within a few miles of my hut. Out of it I picked fossil fragments of vegetable stems, and of broken *Ostræa* and *Pecten* shells, closely resembling those still in the adjacent seas, and showing that an elevation of some 200 to 300 feet had taken place here at a recent period. That these subterranean forces whose activity resulted in the varied physical changes which West Java has experienced (such as the subsidence of the Sunda Straits), had not ceased, was brought home to me with all the vivid and indescribable sensations that accompany one's first experience of powerful and unwonted phenomena.

On the 28th of March, 1879, about eight o'clock in the evening, while sitting under my verandah, a sudden shiver and a violent bumping wave passed as it were through me and under my feet, bewildering me, but affording me the ineradicable experience of a violent earthquake. For some thirty seconds my hut and all its contents were lustily shaken, but otherwise no harm was done. Some forty miles away, however, at the base of the Gedé volcano, the village of Tjanjoor was wrecked and several lives lost amid the falling houses, while on the following day volumes of smoke and ashes were emitted by the mountain whose summit formed the background of my view.

One of my most interesting discoveries here was a case of mimicry in a spider, of the kind named alluring coloration by Mr. WALLACE. The spider itself, to which I had given the provisional name of *Thomisus decipiens*, has proved interesting as the type of a new genus, named *Ornithoscatoïdes* by the Rev. O. P. CAMBRIDGE. The great interest attaching to this find, however, is on account of its habits. I had been allured into a vain chase after one of those large, stately flitting butterflies (*Hestia*) through a thicket of prickly *Pandanus horridus*, to the detriment of my apparel and the loss of my temper, when on the bush that obstructed my farther pursuit I observed one of the *Hesperiidæ* at rest on a leaf on a bird's dropping. I had often observed small Blues at rest on similar spots on the ground, and have often wondered what the members of such a refined and beautifully painted family as the *Lycænidæ* could find to enjoy at food seemingly so incongruous for a butterfly. I approached with gentle steps but ready net to see if possible how the present species was engaged. It permitted me to get quite close and even to seize it between my fingers; to my surprise, however, part of the body remained behind, and in adhering as I thought to the excreta, it recalled to my mind an observation of Mr. WALLACE's on certain *Coleoptera* falling a prey to their inexperience by boring in the bark of trees in whose exuding gum they became unwittingly entombed. I looked closely at, and finally touched with the tip of my finger, the excreta to find if it were glutinous. To my delighted astonishment I found that my eyes had been most perfectly deceived, and that the excreta was a most artfully coloured spider lying on its back, with its feet crossed over and closely adpressed to its body.

The appearance of the excreta rather recently left on a leaf by a bird or a lizard is well known. Its central and denser portion is of a pure white chalk-like colour, streaked here and there with black, and surrounded by a thin border of the dried-up more fluid part, which, as the leaf is rarely horizontal, often runs for a little way towards the margin. The spider, which belongs to a family, the *Thomisidæ*, possessing rather tuberculated, thick, and prominent abdomened bodies, is of a general white colour; the underside, which is the one exposed, is pure chalk white, while the lower portions of its first and second pair of legs and a spot on the head and on the abdomen are jet black.

This species does not weave a web of the ordinary kind, but constructs on the surface of some prominent dark green leaf only an irregularly

shaped film of the finest texture, drawn out towards the sloping margin of the leaf into a narrow streak, with a slightly thickened termination. The spider then takes its place on its back on the irregular patch I have described, holding itself in position by means of several strong spines on the upper sides of the thighs of its anterior pairs of legs thrust under the film, and crosses its legs over its thorax. Thus resting with its white abdomen and black legs as the central and dark portions of the excreta, surrounded by its thin web-film representing the marginal watery portion become dry, even to some of it trickling off and arrested in a thickened extremity such as an evaporated drop would leave, it waits with confidence for its prey — a living bait so artfully contrived as to deceive a pair of human eyes even intently examining it.

Leave Genteng — Native blacksmiths at Sadjira — Hot springs of Tjipanas — Birds and plants at Tjipanas — Invitation to Kosala — The Kosala estate — The curious disease Lata — The Wau-wau — Birds — Bees — White ants — Great trees — Long drought and its consequences — The *Hemileia vastatrix*, a fungoid blight and the buffalo disease — Flora and Fauna of Kosala Mountains — Singular living ants' nests and their development — Orchids at Kosala and some curious devices for securing self-fertilisation — Ancient remains in the forest — The Karangs and their curious rites — The Badui — Religion and superstitions of the people of Bantam — Leave Kosala.

After a very interesting period spent at Genteng, I removed further to the south in search of a station on the mountains, whose distant slopes I could see covered with the great forest which I had never yet beheld close, and under whose shade I had ever had such an intense longing to roam, the charm of whose grandeur, after spending unbroken years in it, remains still as one of the most delightful reminiscences of my residence in the tropics. Halting for a night at Sadjira I was taken by the chief of the village to see numerous blacksmiths at work in the manufacture of knives and krisses. The bellows used by them in order to give a continuous blast was made of two large cylinders of bamboo vertically set in the ground, in each of which a piston made of a dense bunch of feathers wound round a rod, was worked alternately, the wind being conducted through a small tube at the bottom of each bamboo, to meet in one pipe before passing below the fire.

*Pandè* is the Sundanese term for a worker in iron; the word is of Sanscrit origin, and originally meant "learned." Though this signification is not attached to it by the natives now, the smiths are held in the greatest esteem by them. Before the Hindu invasion the people of Java used only stone implements and hatchets, often of great elegance of design and beautifully polished and turned. Dr. SOLEWIJN GELPKE, the director of "the cultures" in Java, has formed at great cost a splendid collection of the implements of the stone age of the island, some of which I had the pleasure of examining on my way home in 1883. Of the beautiful workmanship of the early Javanese one or two fine specimens are to be seen in the ethnological collection in the British Museum.

In the village of Tjipanas, in the Tjiberang valley, distant only a few miles from Sadjira, I spent a week. The village derives its name from the *hot-springs* (which the name signifies) that issue from the ground there at a temperature of 137°–140° F. The place is permeated with the odour of sulphur rising from the springs, which had been dug out into cisterns, round which a crowd of sufferers from long distances were constantly seated, bathing their diseased and ulcerated limbs and rheumatic joints.

An abrupt hill which overshadowed the village, rising up to about 1000 feet above the sea, reminded me, in the way in which it was composed of great blocks of disrupted rock lying in all positions and at every angle one on another, of the titanic structure of the hills of Cintra to the north of Lisbon. Both probably owe their disintegrated condition to the constant earthquakes by which they are shaken. Growing on the thin soil on the tops of the rocks I gathered one of the most conspicuous of ground orchids, a tall white-flowered species of *Calanthe*, nearly all of whose flowers I was surprised to find had been shed without being fertilised; while in the crevices grew luxuriant Osmundas (*O. javanica*) closely resembling the Royal-ferns found at home.

In the young forest on its slopes I shot three interesting birds; a male and female of the *Platylophus galericulatus*, a crow-like bird with a handsome black crest resembling a cockatoo's, finally settling the question that Count SALVADORI was correct in asserting its Sumatran ally (*P. coronatus*) to be a distinct species, and not the female of the Javan bird as was supposed by Mr. ELLIOTT; the other the Fairy Blue-bird (*Irene turcosa*), one of the finest plumaged birds of the island, which is highly prized in Europe for plumassiers' purposes. Its wings, throat and breast are deep velvety black, while its head, back and tail are of glistening turquoise-blue, as if the colour had been enamelled on in an unbroken sheet. It was found quite solitary or in company only with its mate, and never in flocks.

I was pleased to see the liveliness of the village children, who amused themselves with games very similar to those of children at our country schools at home — games of marbles played with small stones, very like what is called *keip* in the north of Scotland, with varieties of chevy, tig, and blind-man's buff.

Hearing that I had come to reside in the village, a countryman, Mr. H. LASH of the Kosala estate, sent me a warm invitation to make his house in the mountains my headquarters, which, as Tjipanas was a very unprofitable station, I was only too glad to do. Kosala was only a forenoon's ride up through winding valleys to an elevation of 1800 feet.

My gratitude can never be warmly enough expressed to this esteemed friend (now, I regret to say, no more) and his accomplished wife, for their great hospitality and kindness; and for the assistance which for many months was afforded me by my host, both personally and through his servants and horses, in making botanical collections in the large stretch of virgin forest which he owned, specimens of whose great trees were special desiderata with me.

Orchids abounded in great variety in the unopened forest, while the tree trunks that had been lying felled in the coffee gardens for some time were overrun with the species more delighting in sunshine. Being soon struck with the large number whose flowers fell without setting any fruit, — a fact that first struck me while botanising some years before in the south of Europe — I determined to institute a series of observations on these plants, a project in which Mr. LASH — himself one of those who sedulously

cultivate science in their leisure hours — entered with the greatest interest, and never wearied of personally searching for specimens, for whose rearing he put a great part of his beautiful garden ungrudgingly at my disposal.

The estate house, planned by himself, was a large tiled edifice of planks not subject to the attacks of insects, elevated a few feet on piles standing on an asphalt floor, isolated by a stream of water entirely encircling the building, so that it was absolutely free from the tropical pest of ants. Perfectly constructed and furnished for a tropical climate, and provided with a large and valuable library, it was admirably situated for a botanical station — the hills rising round it to three thousand feet — whose advantages the want of the necessary instruments alone prevented me from fully utilising. In no part of the world can the climate reach greater perfection, I think, than in the mountain regions of these islands, among which I first felt the real charm of the life I had espoused.

The first thing of interest to attract me, within a few hours of my arrival at Kosala, was a case in one of the servants of the house of that curious cerebral affection called by the natives *lata*. It is of a hysterical nature, and is confined chiefly to women, although I have also seen a man affected by it. On being startled or excited suddenly, the person becomes *lata*, losing the control of her will, and cannot refrain from imitating whatever she may hear or see done, and will keep calling out as long as the fit lasts the name — and generally that word alone — of whatever has flashed through her mind as the cause of it: "He-ih-heh, matjan!" (tiger); "He-ih-heh, boorung besar!" ( a great bird). Her purpose will be arrested, as, if walking, she will stop short, and on going on again will often follow some other course. The prefatory exclamation is an invariable symptom, seemingly caused by involuntary hysterical inspirations. According to the degree of alarm the symptoms may remain only a few moments or last for the greater part of a day, especially if the patient be prevented from calming down. The afflicted, if not very seriously affected, are not altogether incapacitated from performing the duties to which they are accustomed. The most curious characteristic of the disease is their imitation of every action they see. On one occasion, while eating a banana, I suddenly met this servant with a piece of soap in her hand; and, perceiving she was slightly *lata*, but without appearing to take any notice of her, I made a vigorous bite at the fruit in passing her, an action she instantly repeated on the piece of soap. On another occasion, while she was looking on as I placed some plants in drying paper, not knowing that caterpillars were objects of supreme abhorrence to the natives, I flicked off in a humorous way on to her dress one that happened to be on a leaf; she was instantly intensely *lata*, and, throwing off all her clothing, she made off like a chased deer along the mountain road, repeating the word for caterpillar as she ran, until compelled by exhaustion to stop, when the spasm gradually left her. My own "boy," who would unconcernedly seize all sorts of snakes in his hands, became one day *lata* also, on suddenly touching a large caterpillar. My host's maid once, while alone at some distance from the house, having come unexpectedly on a large lizard — the Baiawak — was seized by a paroxysm; dropping down on her hands and knees to imitate the reptile, she thus followed it through mud, water and mire to the tree in which it took refuge, where she was arrested and came to herself. Another case which came under my knowledge was more tragic in its results. This woman, startled by treading in a field on one of the most venomous snakes in Java, became so *lata* that she vibrated her finger in imitation of the tongue of the reptile in front of his head, till the irritated snake struck her; and the poor creature died within an hour.

During the attack the eyes have a slightly unnatural stare, but there is never a total loss of consciousness, and throughout the paroxysm the patient is wishful to get away from the object affecting her, yet is without the strength of will to escape or to cease acting in the way I have described. *Lata* persons are constantly teased by their fellows, and are often kept in an excited state for whole days.

In the early mornings here, I was at first constantly awakened by the loud plaintive wailings of a colony of Wau-waus, one of the Gibbons (*Hyalobates leuciscus*) from the neighbouring forest, as they came down to the stream to drink. On first hearing their cries one can scarcely believe that they do not proceed from a band of uproarious and shouting children. Their "Woo-oo-ŭt — woo-ut — woo-oo-ŭt — wut-wut-wut — wutwutwut," always more wailing on a dull, heavy morning previous to rain, was just such as one might expect from the sorrowful countenance that is characteristic of this group of the Quadrumana. They have a wonderfully human look in their eyes; and it was with great distress that I witnessed the death of the only one I ever shot. Falling on its back with a thud on the ground, it raised itself on its elbows, passed its long taper fingers over the wound, gave a woful look at them, and fell back at full length dead — "saperti orang" (just like a man), as my boy remarked. A live specimen brought to me by a native, I kept in captivity for a short time, and it became one of the most gentle and engaging creatures possible; but when the calling of its free mates reached its prison-house, it used to place its ear close to the bars of its cage and listen with such intense and eager wistfulness that I could not bear to confine it longer, and had it set free on the margin of its old forest home. Strange to say, its former companions, perceiving perhaps the odour of captivity about it, seemed to distrust its respectability, and refused to allow it to mingle with them. I hope that amid the free woods this taint was soon lost, and that it recovered its pristine happiness. The habits of the Wau-wau closely resemble those of the Siamang of Sumatra.

Large stretches of the forest in the immediate neighbourhood of the house were planted in coffee gardens, cultivated not as in Ceylon in the open sun, but under moderate shade chiefly of the *Erythrina indica*, in patches cleared out of the forest some distance isolated from each other so as to prevent the spread, if possible, of any outbreak of the coffee disease (*Hemileia*), and to give each garden a chance of escape. Seen from the heights above, these parterres scarlet with erythrina flowers, had a very brilliant effect on the landscape. In the newer gardens many of the felled trees still lay rotting, and there insects and birds were in abundance; but Java has been so well collected over by excellent entomologists and naturalists for so long a period that few novelties could be expected. Nevertheless, in all departments, species of interest were constantly falling under my notice for the first time.

I used to place a lamp close to my open window, in hope of attracting moths; but, while very unsuccessful in this respect, I had frequent visits from the smaller sorts of bats, which, on my slamming the window to, were, though safely trapped, not ensnared within the folds of my butterfly net without a deal of clever dodging on their part, and of noisy disturbance of furniture on mine. Of these one was a very rare species, *Calops frithii*, and another has been described as new to science by Mr. OLDFIELD THOMAS, under the name of *Kerivoula javana*, a form intermediate between the Philippine and New Guinean types.

For many months after my arrival the earliest hours of the morning were always resonant with the rich deep notes of the Tjiung or Béo, as the

Javanese Grackle (*Gracula javanensis*) is named. They used to frequent a papaya-tree which grew just outside my window, whose fruit they are extremely fond of, whence they poured forth their song in the intervals of feeding. This bird, which is of a rich metallic blue-black plumage, has the nape of the neck adorned with two deep orange lappets, and is greatly prized as a pet by the natives, from its deep and ventriloquistic voice, its wonderful aptitude in learning to speak and whistle, and for its comical ways. A very high price is often given for a well-trained bird, even by the natives. The Grackle is somewhat difficult to rear at first, but when once accustomed to confinement it thrives well — I have seen one which had been caged for nearly eighteen years — especially if a bamboo cylinder be placed in the cage for it to creep into at night, as, when in freedom, it does into a hole in a tree.

Pink-headed doves (*Ptilopus porphyreus*) fed in flocks on the figs; and at 3000 feet I stumbled on a nestful of six fledglings of *Pomatorhinus montanus*, which were being tended, I was surprised to observe, by three parents; but I was unable to satisfy myself positively whether the additional parent was male or female; my boy, however, who on most subjects was well informed, said that "the female 'Patjingpayor' has always two husbands."

No insect sooner attracts the observation of the new comer than the destructive carpenter bees, *Xylocopa*, which with noisy ostentation are incessantly boring their wide tunnels into the woodwork of every building. To sit watching their entrance, and clay each up in a living tomb of its own digging, was one of the most hilarious amusements of the boys. Many other species of *Hymenoptera* attract attention by their curious persistence in building mud-cells from every hanging thread, in locks and hollow tubes, and in every unoccupied corner, stocking them with the caterpillars and spiders which is all the store their parental feelings induce them to lay up for the benefit of their progeny.

A colony of these bees had covered the stems of a species of *Asclepias*, overgrowing the face of a high cliff; and it took a sharp eye to distinguish their nests from clusters of the withered leaves of the climber. Composed of chips of leaves glued together, they were protected from the rain by a projecting roof, which for the purpose of concealment was cunningly shaped like the foliage of the plant itself. There was quite a crowd of them, and as they circled about, their dark wings flashing in the sun as they darted out and into their nests, they reminded me of swallows about a church window.

Less obtrusive, more destructive, but full of interest, are the operations of the various colonies of termites or White-ants. It is impossible to observe the habits of those that bore in the interior of planks and trees; but by the species, that build large excrescences on the tree-trunks, one must admire the specially happy way in which has been settled the difficult question of how to keep their thoroughfares clean and unobstructed, and with the least trouble dispose of the refuse of so large a colony. It is worth while to break down a portion of their tough walls, to watch for half an hour the outrush of the city guards with their *pi[c]kelhaube* heads, who with elevated antennæ sniff round everywhere for the cause of alarm, charging about frantically, nodding and beating their spiked frontlets against the walls in a most threatening way, till they think the danger past, when they retire and order out hordes of builders to repair the breaches, who, distinguished at once by the absence of a frontal spike, have till then kept away from the scene.

After a general survey of the ruins, each worker retires to fetch a small squarish chip, carefully examines the exact place into which it is to be built, then applying to that spot the tip of its abdomen, it excretes a drop of a pale glutinous substance, places in it the chip, and hammers it down by the combined application of its maxillæ and antennæ. While the building is going on a company of soldiers stalk about the walls guarding the workers, every now and then tapping their heads with the conscious air of a constable reminding them that his presence is their safety. Thus block after block with amazing rapidity is cemented together, and the sewage of the colony is piled into the odourless homogeneous walls of their dwelling.

I was astonished one day in making a sweep through a swarm, as I thought of bees, which was buzzing overhead, to find that it was composed of flies called by the natives *Papantong*, a species nearly related to our common Bluebottle.

Above the coffee gardens the heights, up to 4000 feet, were clothed with virgin forest, full of noble giants of the woods. In the gardens many of the finest of these trees had been allowed to stand, where they exhibited all the stateliness and grandeur of stem and crown which can be fully appreciated only when surveyed at some distance off. Prominent for their straight and shapely pillar-like stems stand out the Lakka (*Myristica iners*), the Rasamala (*Liquidambar altingiana*), and the white-stemmed Kajeput trees (*Melaleuca leucadendron*), all of them rising with imposing columns, without a branch often for 80 and sometimes 100 feet. Of the other stately trees here, I noticed the Mangosteen (*Garcinia mangostana*) and the *Vernonia javanica*, a member of a family, the *Compositæ*, that in our own country never attains any importance greater than that of a moderate herb.

The season, however, was a very unfortunate one for enlarging my herbarium. Little over ten per cent, of all the forest trees in 1879 produced either flower or fruit. During 1877 a great scarcity of rain prevailed, while in 1878 almost an unbroken drought existed during the East-monsoon. The parched surface of the ground broke up into ravine-like cracks, which, extending from four to five feet in depth and two to three in breadth, destroyed great numbers of the forest-trees by encircling and snapping off their roots. Shrubs and small trees in exposed places were simply burned up in broad patches. Flowering was almost entirely suspended — so much so that the wild bees could produce no honey, which in ordinary years is one of the very abundant products of the forests. Crops of all kinds failed, while devastating fires, whose origin could seldom be traced, were so frequent in the forest and in the great alang-alang fields, that the population lived in constant fear of their villages and even of their lives and stock. It was in vain that the natives, following their superstitious rites, carried their cats in procession, to the sound of gongs and the clat-

tering of rice blocks, to the nearest streams to bathe and sprinkle them; the rain after such a ceremony *ought* to have come, but it did *not*.

The *Batavia Handelsblad* states the loss in Java, consequent on the drought of 1878, to have been on coffee, ten millions of guilders; on sugar, seven; on tobacco, five; and on rice fifteen — equal in all to a loss in English money of £3,000,000. The West-monsoon (November to March) of 1878–9, memorable for its excessive rain, was followed by an abnormally wet and sunless dry season, which was almost as disastrous for the cultures of the island as its predecessors had been from drought. The coffee-trees produced abundance of flowers, but as scarcely a bee was to be seen anywhere, very few of these became fertilised or produced berries — so easily is the balance of nature disturbed. Later in the season, however, the coffee shrubs produced a second show of flowers, which in a multitude of cases did not proceed further than knobbed buds, the bulk of which I found, by marking and carefully examining them every day, produced fruit without expanding their petals, or, to use the scientific term, cleistogamously.

Marching in company with these disastrous seasons came the terrible epidemic among the buffaloes (the natives' stay in the cultivation of their fields, and the main part of their riches), which had not disappeared in the middle of 1883, being less violent only from paucity of victims. The plague was nearly coincident with the blight — fortunately not of a very severe nature — of the *Hemileia vastatrix* in the coffee gardens. It is a remarkable fact that the buffalo disease and the *Hemileia* appeared without, as far as can be traced, extraneous contagion, on the western coasts of Sumatra (happily for that island in a slight degree only), and on the extreme west of Java, whence it vaulted in most eccentric riot throughout the whole island. Not only was the coffee blighted, but the grass meadows and the forest trees also were so covered, especially in places with a westerly exposure, with a fungoid disease as to become a subject of native remark. One could not help suspecting that these noxious germs had been brought by the winds, and that perhaps even the plague in the herds had resulted from the blighted grass on which they fed. The correctness of this view seems to some slight degree corroborated by the information I subsequently obtained from natives and others in various parts of the Archipelago. In Sumatra, not only the buffaloes suffered, but the elephants, the deer and the wild pigs died in the forest in immense numbers, and, by preying on the dying herds, even the tigers fell victims to the stalking pestilence. In Timor also, in the higher parts of the interior of the island, the cattle were attacked, while in the southern plains the pigs and the horses, which there run wild in herds, were found scattered about in the forest dead.

Closely following the bad years and the bovine pestilence, which deprived them of the means of cultivating their lands, came a scarcity bordering on famine and a fever epidemic of a virulent kind, to which the natives succumbed in thousands. The tale of the woes of their province must surely have seemed to them full and running over when the volcanic wave from the eruption of Krakatoa, in 1883, overwhelmed its seaboard and washed so many of their fellows to destruction.

Notwithstanding the bad season, by hunting far and wide my herbarium grew slowly in bulk, for, though the great trees were in a very destitute condition, herbaceous plants were abundant, and not a few of the smaller shrubs and trees had begun to recover somewhat. Among the most attractive shrubs were the species of figs, of which there was an endless variety. The whole group of the *Artocarpeæ* is remarkable for beauty of foliage and fruit — as the hollow receptacle in which their minute flowers and true fruits are developed is often popularly called — for their striking habit and for their useful products. Some of them, as the india-rubber producing waringins and kawats species of *Urostigma* (*U. microcarpum*, and *consociatum*), are among the giants of the vegetable world, and its most relentless parasites and tyrants. Brought by some wandering bird or fruit-eating quadruped to the cleft of a high tree, the seed germinating drops down all round its host long tendril-like roots, which in a few seasons become indissoluble bonds that interlace, grow together, and close up the tree-stem that gave it its support, till its life is choked out, and only here and there, before it finally disappears, can it be seen through latticed apertures, like an Inquisition martyr built into the wall. The young kawat grows, shoots upward its top and

"spreads her arms,
Branching so broad and long, that on the ground
The bended twigs take root; and daughters grow
About the mother-tree, a pillared shade."

Less stately but not less beautiful are the shrub forms, the species of Hamplas (*Ficus microcarpa*, *amplas*, and *politoria*) whose rough leaves provide the natives with ready-made sandpaper; the *Ficus cordifolia*, the Amismata (*Ficus aspera*), and the Kihedjo — a bushy shrub, whose fruit, always in profusion along its branches, is when ripe of a rich purple hue, and unripe of the brightest vermilion or carmine colour, in brilliant contrast to its dark foliage; while the semi-parasitic climbing *Ficus radicans* delights to cling to the tallest trees of the forest. Its fruit, which is as large as an orange, is put forth throughout the whole extent of its stem in profuse abundance, massed in clusters in every stage of growth; and as these in their passage to maturity assume all the different brilliant hues by which rich orange changes into the sombre shades of purple, the effect against the background of the tree-stem and of its own singularly chaste foliage is striking in the extreme, and is one of those objects that the eye can meet every day with renewed pleasure.

The highest mountain in this neighbourhood attains an elevation of nearly 5000 feet, and for the last 500 yards of its ascent presented many interesting features. In producing plants rarely found at so low an elevation on higher mountains, the Javan flora on the pure volcanic clay differs from that where the soil is more overlaid with forest humus. Two ferns, a species of *Gleichenia* and the broad-fronded *Dipteris horsfieldi* — here at its lowest altitudinal limit — profusely covered the ground; and, as if stretching their utmost towards the heights where they naturally grow, rhododendrons and a beautiful creeping species of *Ericaceæ* (*Gaultheria repens*) clothed the tops of the tallest trees. The lemon-scented laurel (*Tetranthera citrata*), whose leaves and

fruit give out a sweet odour that can be detected a long way off, grew in clumps; and its fruits, a favourite food of the Bulbuls and the Bell-birds, retain their perfume even after they have been dropped by these birds.

At the summit pitcher-plants (*Nepenthes phyllamphora*) appeared in profusion, climbing up the trees and running over the ground among the moss, out of which peeped the delicate bright star-like flowers of the *Agrostemma montanum*, which always reminded me of the pretty European Chickweed Winter-green (*Trientalis europæa*) of our northern woods. On one of the lower knolls I found perhaps the most interesting plant in my Javan collection, a species of *Petræa* (*P. arborea*), growing entirely wild in the forest. This genus, belonging to the family of the *Verbenaceæ*, is almost entirely confined to the South American continent; and it is of extreme interest to find it, in this inexplicable way, cropping up in a region so far removed from the centre of its distribution. A species from the island of Timor occurs, without history, in the collection in the British Museum made by Mr. ROBERT BROWN; but these are the only two examples, so far as I am aware, hitherto collected uncultivated in the Old World.

The 14th of June is to me memorable as being the day on which for the first time I saw in its native habitat, and gathered there, that most singular of the vegetable productions of the Indian Archipelago, the *Myrmecodia tuberosa* and *Hydnophytum formicarum*. Their most striking characteristic will be indelibly marked in my remembrance by the sensations other than mental, by which their acquaintance was made.

In tearing down a galaxy of epiphytic orchids from an erythrina tree, I was totally overrun, during the short momentary contact of my hand with the bunch, with myriads of a minute species of ant (*Pheidole javana*), whose every bite was a sting of fire. Beating a precipitous retreat from the spot, I stripped with the haste of desperation, but, like pepper-dust over me, they were writhing and twisting their envenomed jaws in my skin, each little abdomen spitefully quivering with every thrust it made. Going back, when once I had rid myself of my tormentors, to secure the specimens I had gathered, I discovered in the centre of the bunch a singular plant I had never seen before, which I perceived to be the central attraction of the ants. It was called *Kitang-kurak* by my boy, who said it was the home of the ants. I was overjoyed with the revelation that a slice struck off by my knife, made of an intricate honeycombed structure swarming with minute ants — a living formicarium.

In the space of a short search I found, generally high on the trees, abundance of specimens of both genera, which, not without several futile attempts and many imprecations and groanings on the part of my boys, were brought to the ground; and, at the ends of a pole over their shoulders, up which the infuriated dwellers would ascend to spread over their bare bodies to their frequent discomfiture, they were at last safely deposited in a spot in Mr. LASH's garden, where I could examine them with comfort without disturbing their inhabitants...

Observing the ants often employed in carrying out whitish particles, I at first conjectured that the irritation of their digging out a dwelling must have induced the swelling of the bulb; and, curious to see the *modus operandi* of its commencement, I decided to raise a few of them from seed. This turned my attention to their flowers and fruit. The flowers are produced in deep spine-protected pits on the axis surmounting the bulb, and are remarkable for the extreme rapidity with which the cycle of their functional changes are performed. The pellucid white flower appears, and is followed by an orange, watery fruit, whose seeds ripen and often germinate in the little pits where they grow, all within the space of thirty-six hours.

Some years later Dr. BURCK, of the Buitenzorg Gardens, most kindly showed me specimens and microscopic slides illustrating some interesting observations [3] he had made on these flowers: that the corolla segments rarely open (though a slight touch can effect it); that the pollen grains exsert their pollen tubes while still in the anthers; and that both the external and the internal surfaces of the lobes of the pistil are covered with papillæ, indicating that these surfaces are functionally active.

I have never observed these flowers approached by the ants that infest the interior, nor by any other insect, which to gain admission to the flower, even if open, must be very small indeed. The anthers and the pistil do not seem to reach maturity together, yet it would seem that self-fertilisation alone can take place; perhaps the tubes of the pollen grains which fall to the bottom of the corolla manage to reach the lower lobes of the pistil and produce fecundation.

The seeds I planted germinated with great freedom, and I cultivated quite a number of young *Myrmecodia*, whose growth I watched with the greatest interest. Many of them I kept quite isolated from the interference not only of the *Pheidole javana*, which seems to be the only species of ant which lives in these plants in their native state, but of all other species, and I was surprised to find that from their very earliest appearance *this curious galleried structure arose without the presence of the ants*, and that the plants continued to grow and thrive vigorously in their absence as long as I cultivated them. Some bulbs had a single canal reaching to their centre from a round orifice opening generally close to the little tap-root; others presented one or two loculi in the interior, without any communication at first with the exterior, partially full of a spongy substance looking like its own degenerated tissue. These chambers invariably developed a spongy pith — which in a section it was not difficult to trace out in advance in the still fleshy substance — towards and to open at last at one or more spots on the exterior of the bulb. Secondary galleries, arising in the same manner as the primary, soon formed communicating channels, extending with age, throughout the whole of the growing bulb. At a later period, in Amboina, where the *Myrmecodia* and the *Hydnophytum* were very abundant, I found many specimens containing a large central

[3] These have since been published in the 'Annales du Jardin Botanique du Buitenzorg,' vol. iv, p. 16.

and quite isolated chamber full of water — not rain-water — round which radiated the galleries tenanted by ants and their larvæ of the same species as in Java.

Since my original observations, Dr. MELCHIOR TREUB, Director of the Botanic Gardens in Buitenzorg, has conducted and published[4] a series of important researches into the development of these bizarre plants, which have confirmed generally the observations I had made, and have proved besides that what I have called degeneration is the result of a transformation into *cork* of the tissue of the plant; which, becoming entirely dried up, gradually extends the galleries towards the exterior, when the fluffy mass disappears or is carried out by the ants.

Notwithstanding these researches it remains still a mystery what causes the development of these corky cells, what advantage the plant derives from its unusual structure, and what is the mutual benefit of this close relation between insect and plant. That the ants should so persistently infest and yet derive no advantage beyond accommodation from the plant, seems unlikely; it is probable however that the papillæ in the galleries, whose function is still an enigma, may afford some nourishment to them, but that the insects are not absolutely indispensable to the perfect performance of the functions of the plant is certain from Dr. TREUB's observations. He suggests that they perhaps ward off enemies from the plant, or that they may remove, for their own nourishment, injurious excretions from the papillæ of these channels whose office may be to distribute air through the fleshy mass of the bulb. Altogether these *Myrmecodia* are among the most singular of vegetable productions, showing us how much we have yet to learn of the intricate processes of nature.

I gathered here another interesting specimen in some leaves of the *Bryophyllum calycinum*. As is well known, the marginal notches of the leaves of this plant, when laid on the ground or in a damp place, produce buds which develop into new plants. In the leaves I gathered here, however, *complete flowers and fruit* were produced directly from the notches.

While botanising in Portugal, in the spring of 1877[5], I was remarkably struck by the number of orchids I gathered that seemed never to have had an effective visit paid them by any of the crowd of bees, butterflies, and beetles, among which they blossomed. They were mostly terrestrial species, *ophrys* chiefly, and were some of them handsome, and very sweetly scented; yet they might as well have wasted their sweetness on the desert air, for scarcely any of them ever lost their pollen masses, or had these fertilising grains applied to their own stigmas. Since then I have carefully examined all orchids that I have encountered, and have been surprised at the immense numbers which — possessing brilliant, small, and not seldom even large flowers, often highly perfumed — never or very rarely produce seed capsules, but which blossom and fall without benefiting in any way their race. At Kosala I was able to continue my observations both on those growing naturally in the forest as well as on those I reared in Mr. LASH's garden, where, after once taking to the trees they were as nearly as possible under natural conditions.

The *Cymbidium tricolor* produces flower-spikes often attaining a length of nearly four feet, studded with florets which are rather sombre in colour; yet it could scarcely be passed without attracting admiration. Of the florets of several plants I counted, seventy-nine per cent. had their pollinia intact, after, to all appearance, having been exposed for a long time, and of those that had lost their pollinia not one stigmatic surface had pollen grains applied to it. On another occasion the whole of the florets examined were unvisited; while on a third occasion eighty-nine per cent. of the florets examined had their pollinia safe in the anthers, nine per cent. being damaged, either having lost their labellum or having the column eaten by the larvæ of a species of *Coccinellidæ*. One alone was fructified.

I gathered the rather rare *Cymbidium stapelioides*, growing at a height of 2600 feet above the sea, flowering on a fallen tree. I brought it home, 1000 feet lower, and fixed it to a tree-stem, to which it at once took kindly. None of the flowers which were expanded when I found it were fertilised; but one of the bulbs had a stem with a solitary capsule. For three weeks the plant remained in the condition in which I found it, its large and handsome, though somewhat dull-coloured, flowers retaining their perfect freshness during all this period. I then took compassion on its barren state, and fertilised from their neighbours four of its florets. These alone of the sixteen flowers bore fruit. A couple of months later a fine new spike appeared, which I left to its own resources. For between four and five weeks it exhibited a very fine truss of twelve flowers; but not one seed capsule was produced. The insect life at the lower station seemed quite as abundant as at the higher. This orchid possesses no nectary, and its odour, if not pleasant, is not disagreeable. The viscid disk of its pollinia is remarkable for its elasticity. After removing a pollen mass from the anther, I applied it to the stigma of another floret, and on withdrawing the pencil to which it was adhering, it sprang back with an audible snap, the viscid disk stretching quite one-eighth of an inch, without leaving pollen on the stigma, for the floret did not set a capsule. The same result followed after allowing the pollen to remain for some seconds in contact with the stigmatic surface. After the lapse of a week the viscid disk still retained its elasticity unimpaired, so much so that I was able to extend it as often as ten times for various distances up to nearly one-fifth of an inch before the connection gave way — a sharp snap always accompanying its relaxation.

One of the prettiest and commonest orchids here was a pure white *Dendrobium* (*D. crumenatum*), which suddenly appears in flower on all the trees of a district nearly on the same day. I have examined many hundreds of flowers, and I am quite sure, though I have not kept very accurate statistics of the numbers, that not one in eighty ever sets a seed capsule.

Growing terrestrially in abundance in damp shady situations is another group of this family belonging to the genus *Calanthe*. *Calanthe veratrifolia* produces quite a dense head of elegant white flowers, but the number of those that become fertilised are in enormous disproportion to those that fall off barren. I have examined plants in numerous localities, in heights amid the dense forest, as well as in more open situations; I have studied them low down, both in the sun and in

[4] In the 'Annales,' sup. cit., vol. iii, pp. 130–157.
[5] *Nature*, vol. xvi, p. 102.

the deep shade, but have invariably found that a very small proportion produces fruit. Generally the pollinia are found in the anther after the fall of the flower: but often they are absent, without any pollen being left in return on the stigma. In five different plants, out of 360 florets examined, 109 were withering with intact anthers, or had lost their pollen and were unfertilised, 245 had fallen off, six only had produced capsules. These are not selected instances, but the result of the examination of five plants as they occur in my note-book. I have several times found in various species of *Calanthe*, specimens which at first I thought to be *cleistogamously* fertilised, where the ovules were enlarged in the ovary, and the flowers quite open; but close examination has shown that this is the effect of the irritation of a small species of *Hymenoptera* — a *cynips* probably.

Mr. DARWIN, in his 'Fertilisation of Orchids,' enumerates but four instances of self-fertilisation as coming under his observation, namely: in *Ophrys apifera*, by the falling forward of its own pollinia, which are then, by the agency of the wind, brought into contact with the stigma — the plant being capable also of cross fertilisation; in *Peristylis viridis*, which is possible to be self-fertilised by its own pollen from the head of the visiting insect; in *Cephalanthera grandiflora*, which is perpetually self-fertilised by its pollen grains that rest against the upper sharp edge of the stigma thrusting down their pollen tubes into the ovary; lastly, *Dendrobium chrysanthum*, which may possibly be self-fertilised by its own peculiar acrobatic pollen. In the additional instances here given, some will be found to be singular and different, I believe, from any hitherto recorded . . .

The estate of Kosala derives its name from the rounded hill above the house. The word is of Sanscrit origin, but its meaning is unknown. It is a country along the bank of the Sarayu, forming a part of the modern province of Oude. It was the pristine kingdom of a solar race, and in the time of Buddha its principal city was Sewet (Srâvastî). There is another Kosala in the Deccan (Dakshina Kosala); so Kosala or Kusala is the name of a land or a race. *Ala* occurs as a termination in many names of countries, but the root *Kôsh* or *Kush* has such an immense variety of significations that it is impossible to find a good translation for it.

The city of Sewet in Kosala was visited in A.D. 401 by the Chinese Buddhist pilgrim FAH-HIAN, and where he saw the famous sandal-wood figure made by order of the king of Kosala. He found at some distance from the city a copse called Aptanêtravana ("recovered sight"), where originally five hundred blind men lived who were restored to sight by Buddha. The blind men threw their staves on the ground, which forthwith grew up into trees and formed a sacred grove or copse. The name has most probably come down from Hindoo times to the present associated with some sacred legend whose influence hovers still over the spot; for when the coffee gardens were being made the natives refused to fell the forest that grew on the Kosala hill, and only under compulsion could they then be persuaded to enter it.

Under its shade there stand several mounds, blocks, and slabs which Mr. LASH conducted me one day to see. On entering the forest we were somewhat surprised to find a portion of the ground newly cleared of underwood from about several of the stones, and against them standing the remnants of small torches of sweet gums which had been offered before them. I felt certain that this was the work of none of the surrounding people who were afraid to enter the copse.

I decided therefore to make a full survey of the buried ruins, and after some difficulty I succeeded in securing, for a consideration, the services of a youth who was willing to brave with me the wrath of the guardian spirits of the grove, and assist me in the sacrilegious work of hewing which my operations would entail.

In the immediate neighbourhood, was discovered a bronze bell of undoubted Hindoo manufacture, its handle ornamented with the sacred bull, but without the clapper which had dropped from its ring; and within the boundaries of the grove stands a rude figure of the Buddha, with elevated finger, as if in the act of instructing.

The ruins consist of terraces built up round the hill, which probably once encircled it entirely, but part of which has evidently extended where now the coffee plantation exists, and has been obliterated perhaps in the cultivation of forest patches by the natives in former periods. Only the portion surrounding for some distance that used by the worshippers has been left unmolested. There the terraces are completely laid out in quadrilateral enclosures, their boundaries marked out by blocks of stone laid or fixed in the ground, which with singular exactitude lie within a degree of the true magnetic cardinal points. Here and there on the terraces are more prominent monuments — erect pillars surmounting oval piles of stones; flat slabs on the ground supporting egg-shaped blocks, which are distributed in many spots in such numbers and perfection of shape that to have made them or searched the brooks for them must have entailed a vast expenditure of time and trouble. Here and there also I found flat slabs raised on end and remains of circular paved areas, set round with upright blocks of stone. Specially noteworthy was a pillar, erect within a square marked out with stones on the ground, round which the worshippers had plaited a fringe of Areng palm leaves. This same stone is thus decorated at every visit made by the worshippers to the sacred grove.

At the base of two of the stones, where perhaps they have lain for unknown time, I found an earthenware jar, both of them somewhat broken, but of elegant shape and artistic design, not of ordinary native pattern or workmanship; but, besides these jars, the egg-shaped stones and the image, all the monuments were of rough stone and without inscription or sign of handicraft. At the base of all the principal mounds and pillars I found remains of their offerings.

I learnt that the worshippers belonged to the tribe called the *Karangs* or *Kalangs*, who lived in a village lying several days' journey to the southward. Four times a year a procession of old men and youths repairs, by paths known only to themselves, through the dense intervening forest in a direct course by valley and mountain, to this sacred grove; the old men to worship and make offering, the youths to see and learn the mysterious litany of their fathers. The old men lead the way; the rest follow in single file, no one breaking the silence of their journey. Should any one be encountered by them on the way their pilgrimage is considered for that time unpropi-

tious, and they return to their village to wait for a more favourable occasion. On their arrival with early morning at the grove they camp in a small hut, cleanse the ground about the sacred mounds, and perform during the night or on the following day the rites known to themselves alone; in the evening they take their departure to an adjoining valley, where below a great overhanging rock they wait till break of next day, when they return home in a similar secret and silent manner to their coming. They all wear garments of cloth striped with black and white.

RAFFLES[6] has given an interesting and full account of these people in his 'History of Java' from which I make the following extract: "They were at one time numerous in various parts of Java, leading a wandering life, practising religious rites different from those of the great body of the people, and avoiding intercourse with them, but most of them are now reduced to subjection, and are become stationary in their residence, having embraced the Mahomedan religion. In a few villages their peculiar customs are still preserved. Although by tradition their descent is from a princess of Mendang, Kamūlan, and a chief transformed into a dog, they have claims to be considered the actual descendants of the aborigines of the island. They are represented as having a great veneration for a red dog, one of which is generally kept by each family, which they will not permit to be struck or ill-used.[7] When a young man asks a girl in marriage he must prove descent from their peculiar stock. When the Kalangs moved from one place to another, they were conveyed in carts, with two solid wheels with a revolving axle, drawn by two pairs of buffaloes, according to the circumstances of the party. In these were placed the materials of huts, implements of husbandry, &c. In this manner, until forty or fifty years ago, they were continually moving from one part of the island to another. They have still their separate chiefs, and preserve many of their customs. They are treated with contempt by their Sundanese neighbours, so that 'Kalang' is considered an epithet of contempt and disgrace."

Living despised and secluded in villages apart by themselves, they follow the rites and customs that have descended to them from their forefathers with the superstitious awe that comes of ignorance. The pillars in the centre of rudely circular heaps, as perhaps also the ovoid blocks resting on tablets and other shaped slabs, point no doubt to the celebration here of phallic rites and to the worship of the Linga and Yoni, the emblems of Siva and Vishnu. It is interesting to find the goblets or vases at the base of the upright pillars; they point probably to the "mystic vessels or goblets in the hands of Siva in the image of this god in Indian temples in central Java." Not less significant is the upright stone decked with palm-leaf fringe, a symbol round which these rude and ignorant villagers, following their blind traditions, weave to this day hangings, "just as the women did for the Ashera in the Jewish temple, and the Athenian maidens [following *their* old traditions] embroidered the sacred peplos for the ships presented to Athene at the Dionysiac festival" (Cox).

In standing under the forest amid these ancient remains, I felt as if I were having an unbroken view down the ages to distant antiquity; these relics still warm, as they were, with the intermittent fires which have been kept alive from the dim past till now, and echoing with the footsteps of the rude worshippers who, unaffected by the incessant waves of change that have broken about them, are themselves as much ancient monuments as the very blocks of weather-beaten, lichen-matted trachyte, whose purpose is lost to their traditions, before which they torpidly mutter a litany they do not comprehend, and listlessly perfume the air, they know not why, with the odours of their incense.

Not far distant from the Karang dwellings lies the sacred village of Tjibéo, inhabited by the Badui, containing never more nor fewer than forty souls. If their number be increased by birth the overplus must go out and reside in one or other of three neighbouring villages; if their number decrease the deficit must be made up from among the Outsiders, as they call these extraneous villagers. No foot but one of their own — not even of the highest European official — may cross the sacred boundary, which at some distance hedges the sanctity of their abodes. Like the Rodiyas of Ceylon, they eat carrion and the flesh of animals offensive to their neighbours; flesh of buffalo they may eat, but they may not kill the animal themselves, and of fowl also if the life have not been taken by the letting of its blood, but by a stroke on the head. They wear only a short loin-cloth, whose colour must never be other than white striped with black.[8] In speaking to any one not of their own stock, of however high a rank he be, they use the pronouns by which a superior distinctly indicates that he is addressing his inferior. At various periods of the year they also pay mysterious and religious rites to rude venerated blocks of stone, arranged in terraces near their village. The Kalangs are probably an offshoot of the same stock as the Badui, though they are not reckoned among those outsiders who may be received to make up a deficiency in the sacred Forty of Tjibéo, nor do they worship at their shrines. On the high Tengger Mountains, in the east of Java, a colony with rites and customs similar to those of the Badui exists in all the isolation and opprobrium that a schismatic religion can call out.

With the exception of the Karangs and the Badui, the entire population of Bantam profess the Mahomedan religion, which however seems to be merely a lusty and fanatical graft on the pagan superstitions of the ancient times.

On Mount Dangka and on the summits of many of the neighbouring hills I stumbled on groves containing either rocks naturally *in situ*, or stones that had been placed there, which my porters refused to enter for fear of being affected by some sickness or misfortune. "They are

[6] For additional information the reader is referred to Tijdschrift v. Ned. Ind. i. jaarg. ii. deel. p. 295 *et seq*.; iv. j. ii. 217; vii. j. iv. 335 *et seq*.; Bijdragen v. Ind. T. L. en V.-Kunde. iii. Volgreeks, iv. deel.; Indisches Magazin, 1845.

[7] "According to the Zend Avesta, certain dogs have the power of protecting the departed spirits from the demons lying in wait for them on the perilous passage of the narrow bridge over the abyss of hell; and a dog is always led in funeral processions, and made to look at the corpse." — *Macmil. Mag.*, "Village Life in the Apennines," June 1879.

[8] "A magnificent robe having been given to Gotama, his attendant Ananda, in order to destroy its intrinsic value, cut it into thirty pieces and sewed them together in four divisions, so that the robe resembled the patches of a rice-field, divided by embankments, and in conformity with this precedent the robe of every priest was similarly dissected, and reunited." — HENRY'S 'Eastern Monachism,' chap. xii. p. 117 Can the striped garments of the Kalangs and Badui have any reference to the above tradition?

Patapahäan" (places of penance and worship), they would say, and are the sacred spots where they believe their ancestors who, refusing to embrace Mahomedanism, fled to the forests, vanished in invisible forms. Whenever calamity overtakes them — when their crops have failed or they are childless — they repair (in greatest numbers during the month of the chief Mahomedan fast — Ramadan) to these *Tapa*, where they will spend days of fasting and awesome terror, in the hope that the spirits of their transfigured forefathers will grant them the desire of their hearts. In dire sickness, when the slender list of their pharmacopœia has been exhausted, they will as a last resource send to gather lichens from the sacred stones of the despised Kalangs or the Badui, in the belief that a decoction therefrom will avail to ward off or heal their sickness.

It is quite a common thing to encounter by the wayside near a village, or in a rice-field, or below the shade of a great dark tree, a little platform with an offering of rice and prepared fruits to keep disease and blight at a distance, and propitiate the spirits ever lying in wait in gloomy, sunless (and naturally depressing) spots to harm the passer by. This fear of lurking evil ever oppresses their lives. No one can be found brave enough to touch a man struck to the ground, for instance, by lightning; they will cover him up where he fell, with leaves or generally with stable dung, and commit his recovery to nature. If he recover, well and good; but to carry him from the spot, to lift him or meddle with him while unconscious, would be to cry down the Avenger's displeasure on their own head.

In the month of January 1880, Dr. SCHEFFER, the then Director of the Buitenzorg Gardens, wrote to me that, as much virgin forest was being felled among the mountains not far from the Government Cinchona Plantations in the adjoining province of the Preanger, a good opportunity offered itself of increasing my herbarium. This was not a chance to let slip, so, bidding a reluctant farewell to Kosala, I set off for Buitenzorg by the direct foot-road through the forest. The only sound which disturbed the woods was the "Kang-kang-kong" of the "bird of the rainy season," as the native has named a species which disappears or is silent during the dry monsoon — a bird I could never catch a sight of, however, notwithstanding my most wary stalking.

Leave Buitenzorg for the Preanger Regencies — Journey to Bandong in a Post-cart — Bandong — Thence to Pengelengan — Visit to the famous Cinchona Gardens of the Government — Plant-life in the surrounding mountains — The Upas tree — Crater flora — Land-slips and the power of rain — Interesting birds — The Badger-headed Mydaus — The Banteng, or wild cattle — Wild dogs — Leave Pengelengan for Batavia.

After a few days of preparation for my new tour spent in Buitenzorg, I sent off my baggage to the Preanger in the care of a string of coolies, and secured for myself a seat at the moderate rate of twenty cents per mile in the mail-cart which every evening leaves Buitenzorg for Bandong. The mail-cart was not the most luxurious, but it was the cheapest and certainly the most expeditious way of getting over the ground. This cart was a rough edition of our own mail-gig — simply a box on wheels — whose cushionless and slippery top formed a most uncomfortable seat, yet I would not have missed the ride for a good deal. We started with a couple of stout ponies yoked tandem-wise, and in place of side lamps our way was lighted by an immense torch made of splints of bamboo some seven feet long tied together, which a youth, who straddle-wise clung on behind, held to the wind to keep it ablaze.

Our road lay over the Megamendoeng Pass, 4500 feet above the sea. At first the gradient was not very steep, and we proceeded at a fine pace. Towards every post-station, five miles apart all along the road, our progress was heralded by loud shouts, and by the louder shot-like whip-crackings that these drivers are famed for. At each station a halt of three or four minutes sufficed to put in the fresh horses standing ready for us, out blazed a fresh flaming torch, and our plunging and kicking steeds were off again, at a gallop which by voice and whip was not allowed to flag until we pulled up under the next station. By and by the ascent became steeper, and our team had to be augmented by the addition of a buffalo in front of our horses; further up a second was added, till at last the equine was altogether discarded for the bovine element.

Under the soothing evenness of their progress I might have dropped into a pleasant doze; but the night was so beautiful that I preferred to enjoy the picturesque effect produced by the light of the torches on our team and their drivers — who were dressed in short red trousers, deep yellow jackets, and their tartan sarongs thrown sash-wise across their shoulders, and wore immense hats more than two feet in diameter; and to lose none of the charm of the bright starlit night and the fire-flies that illuminated with their fitful light the borders of the forest through which we were ascending whose low moan was the only sound that broke the stillness of the night, for the driver had coiled himself up as best he could, and was fast asleep, and the buffalo-boys walked like mutes at a funeral.

At about midnight we reached the summit of the pass, where it was so cold that I was glad to crouch by the fire of a small hut there, while the buffaloes were being changed. The place of the oxen was now taken by a single horse, which, urged at a pace more swift than safe, carried us down the mountain side into a warmer region in a very short time. The up-hill seat might have been more comfortable; but the down-hill ride was interspersed with practical lessons in dynamics which rather tended to disagree with the general quiet order of one's internal arrangements, yet the sensation of being whirled along at such a rapid speed was full of exhilaration and great pleasure. At 3 A.M. we pulled up at our half-way house — the post-office at Tjandjoor — where I was checked off with the rest of the baggage which had been consigned to the driver at Buitenzorg, re-booked for the remainder of the journey, and handed over to the charge of a new Jehu to be delivered at his destination.

Beyond Tjandjoor the road passed through a more level country, leading to the deep valley of the Tjitaroom. As there was no bridge over the ravine we were, on arriving at the near bank, assisted to alight by what seemed a regiment of walking torches, and with cart and horses transported on a bamboo raft to the further side, where two buffalo friends were in waiting to haul us up the long steep bank out of the gorge, beyond which the road was easy, and the horses, urged to their utmost speed, dashed along

through village after village, rousing the dogs and awakening the sleepers. The night growing into day brought us one of the pleasantest portions of our drive. The grey tints of the short dawn passing gradually through many lovely hues into a delicate blue, and the fresh wooded landscape lit up by the morning sun more charmingly than at any other hour of the day, are the beauties, never wearying to the eye, that accompany the opening of a tropical day. At 8 A.M. we drew rein at Bandong post-office, having accomplished somewhat over eighty miles in thirteen hours.

Bandong is the chief town of the Preanger Regencies, one of the largest and richest residencies in Java. In this province the Government has some of its most extensive coffee gardens, tobacco and cinchona plantations. The town is large and straggling, containing but few European houses; its most interesting building is the residence of the Regent or native governor of the district. In front of his door is a great square, in the centre of which a giant fig-tree grows, beneath whose shade on high days the natives congregate to sport and to pay respect to the chief. Though some 2000 feet above the sea it is hot and close at all seasons, and is not a very pleasant place to live in. The larger part of the trading population is Chinese and Arab, the natives taking little or no part in it; but the district is noted for its beautiful ornamental baskets of bamboo wicker-work.

Bandong stands in the centre of an immense level plain hemmed in on all sides by very high mountains — most of them volcanoes — which discharge their streams into it, whose waters can find only one outlet, the Tjitaroom, which issues from the western angle and flows northward into the Java Sea. In prehistoric times this plain must have been one large lake, till, by the convulsions and eruptions of the volcanic peaks that banked it in, a gap was formed, which drained off the water, and turned its bottom into a fruitful field. On the whole one would have preferred the lake, and Java could then have boasted of one respectable fresh-water sea, a feature of beauty conspicuously and unexpectedly absent from so mountainous and volcanic a country.

After resting a day in Bandong I proceeded to my destination, some thirty miles farther to the south. For fifteen miles of the way it was possible to drive in a spring cart, which I hired in the town; but the rest of the road, which rises to 4500 feet, is very steep, and had to be accomplished on horseback.

The road in the lower districts, shaded at short intervals by leafy Hibiscus trees, passed between hedges of bright yellow-, purple- and red-flowering *Lantana;* higher up broad patches of pink balsam (*Impatiens*), shady *Albizzias*, purple Bintino (*Lagerstrœmia*), tall tree-ferns and a shrubby species of *Cassia* bearing large tresses of bright golden flowers, were met with. A little higher a species of *Datura*, with broad leaves and large white trumpet-shaped flowers, suddenly became abundant. Being utilised by the natives as boundary hedges for their coffee-gardens, it formed by the size and abundance of its flowers a marked feature of the vegetation.

Five or six hours of slow ascent brought us at last to Pengelengan, a small village lying at an elevation of 4500 feet above the sea, on an undulating plateau formed by the inner slopes of the Malawar, Wayang and Tilu mountains, whose summits range from 6000 to 7500 feet, and at several points command a view of the South Indian Ocean. On the outskirts of the village was a comfortable and convenient Government bungalow, in which visitors to this rather out-of-the-way spot could, with the permission of the Resident (always willingly granted), be accommodated for a time. Here I was in the centre of one of the great Government coffee districts, and in the vicinity of its cinchona plantations on the slopes of the surrounding mountains.

One of my first visits was paid to the "Bark" gardens in order to see in a living state these famous trees, and especially that species with cream-coloured flowers, the *Cinchona Ledgeriana*, which had attained so great a celebrity, and could in 1880 be seen, excepting in our Himalayan gardens, almost nowhere else but in the Dutch plantations. It is now little more than thirty years since the Netherlands Indian Government began to cultivate cinchona. Their first seed was brought by HASSKARL, of the Botanical Gardens in Buitenzorg, who had been deputed by the then Colonial Minister to visit Peru to see the tree in its native forests and bring home with him a collection of what seeds he could find. He was unfortunately very unsuccessful, and obtained seeds of only very inferior sorts. In 1866 the Government purchased, for less than £50, a small quantity of seed of a supposed variety of *C. calisaya* sent from America by Mr. CHARLES LEDGER. So well had this species been propagated that there were nearly one million trees, worth more than a million and a half of money, in the gardens, raised from the seed then purchased.

It is well known that cinchona is so liable to hybridisation that it is very difficult to obtain pure seedlings from the seed even of pure trees, the offspring containing very often less alkaloids than their parents. An experiment, which has proved a great success, was made by Dr. MOENS of grafting on the easily reared and quickly growing *C. succirubra* stems, shoots from the highest alkaloid-yielding trees. They have been found to grow very rapidly and to reproduce pretty regularly the same proportion of alkaloids as the trees from which the grafts were cut. Of Mr. LEDGER'S variety, now raised to the rank of a new species by Dr. MOENS, the seed-raised trees may be of many degrees of value, but all contain a far higher percentage of quinine than any other species. I gathered as a memento of my visit some flowers from trees whose bark yielded, with a trace only of any other alkaloid, the extraordinary amount of ten and even thirteen per cent. of pure quinine. Continued cultivation has therefore, it would seem, vastly developed the amount of quinine that these *Ledgerianas* contain, compared with what they yield in their native forests of Bolivia.

The story of how the seed of this priceless tree (which can now be propagated *ad libitum*) reached the Old World is so interesting that I have extracted a few paragraphs from a letter of its introducer, Mr. CHARLES LEDGER, in the *Field* of Feb. 5, 1881, addressed to his brother, evoked by an account of the Dutch Gardens I had contributed to the same journal in 1880:

"While engaged in my alpaca enterprise in 1856, a Bolivian Indian, MANUEL TUCRA MAMANI, formerly and afterwards a cinchona bark-cutter, was accompanying me with two of his sons. He

accompanied me in almost all my frequent journeys into the interior, and was very useful in examining the large quantities of cinchona bark and alpaca wool I was constantly purchasing. He and his sons were very much attached to me, and I placed every confidence in them. Sitting round our camp-fire one evening, as was my custom after dinner, conversing on all sorts of topics, I mentioned what I had read as to Mr. CLEMENT R. MARKHAM's mission [in search of cinchona-seeds]. Now MANUEL had been with me in three of my journeys into the cinchona districts of the Yungas of Bolivia, where I had to go looking after laggard contractors for delivery of bark. It was while conversing on the subject of Mr. MARKHAM's journey, and wondering which route he would take, &c., that MANUEL greatly surprised me by saying: 'The gentleman will not leave the Yungas in good health if he really obtains the *Rogo* plants and seeds.' MANUEL was always very taciturn and reserved. I said nothing at the time, there being some thirty more of my Indians sitting round the large fire. The next day he reluctantly told me how every stranger on entering the Yungas was closely watched unobserved by himself; how several seed-collectors had their seed changed; how their germinating power was destroyed by their own guides, servants, &c. He also showed me how all the Indians most implicitly believe, if by plants or seed from the Yungas, the cinchonas are successfully propagated in other countries, all their own trees will perish. Such, I assure you, is their superstition. Although there are no laws prohibiting the cinchona seed or plants being taken out of the country, I have seen private instructions from the Prefect in La Paz, ordering strictest vigilance to prevent any person taking seed or plants out of the country. More than half-a-dozen times I have had my luggage, bedding, &c., searched when coming out of the valley of the Yungas. [Mr. LEDGER unsuccessfully attempted to communicate with Mr. MARKHAM, who was not permitted to enter Bolivia.] [9]

"You are aware how I am looked upon as a doctor by the Indians. Well, one day I said: 'MANUEL, I may some day require some seed and flowers of the famous white flower, rogo cascarrilla, as a remedy; and I shall rely on your not deceiving me in the way you have told me.' He merely said, 'Patron, if *you* ever require such seed and flowers, I will not deceive *you*.' And I thought no more about it.

"MANUEL was never aware of my requiring seed and leaves for propagating purposes; he was always told they were wanted to make a special remedy for a special illness. For many years, since 1844, I had felt deeply interested in seeing Europe, and my own dear country in particular, free from being dependent on Peru or Bolivia for its supply of life-giving quinine. Remembering and relying on MANUEL's promise to me in 1856, I resolved to do all in my power to obtain the very best cinchona seed produced in Bolivia.

"His son SANTIAGO went to Australia with me in 1858. In 1861, the day before sending back to South America SANTIAGO and other Indians who had accompanied me there as shepherds of the alpacas, I bought 200 Spanish dollars, and said to him: 'You will give these to your father. Tell him I count on his keeping his promise to get me forty to fifty pounds of rogo cinchona (white flower) seed. He must get it from trees we had sat under together when trying to reach the Mamore river in 1851; to meet me at Tacna (Peru) by May 1863. If not bringing pure, ripe rogo seed, flowers and leaves, never to look for me again.'

"I arrived back in Tacna on the 5th of January, 1865. I at once sent a message to MANUEL, informing him of my arrival. At the end of May he arrived with his precious seed. It is only now, some twenty-four years after poor MANUEL promised not to deceive me, manifest how faithfully and loyally he kept his promise. I say *poor* MANUEL, because, as you know, he lost his life while trying to get another supply of the same class of seed for me in 1872–3. You are aware too how later on I lost another old Indian friend, poor POLI, when bringing seed and flowers in 1877.

"I feel thoroughly convinced in my own mind that such astonishingly rich quinine-yielding trees as those in Java are not known to exist (in any quantity) in Bolivia. These wonderful trees are only to be found in the Caupolican district in eastern Yungas. The white flower is specially belonging to the cinchona 'rogo' of Apolo.

"You will call to mind, no doubt, the very great difficulties you had to get this wonderful 'seed' looked at, even; how a part was purchased by Mr. MONEY for account of our East Indian Government for £50 under condition of 10,000 germinating. Though 60,000 plants were successfully raised from it by the late Mr. M'IVOR, I only received the £50.

"The seed taken by the Netherlands Government cost it barely £50.

"Such then is the 'story' attaching to the now famous *Cinchona Ledgeriana*, the source of untold wealth to Java, Ceylon, and, I hope, to India and elsewhere. I am proud to see my 'dream' of close on forty years ago is realised; Europe is no longer dependent on Peru or Bolivia for its supply of life-giving quinine."

In my new locality I experienced, as at Kosala, the same difficulty in obtaining herbarium specimens of the great trees, with a better opportunity of verifying the fact that the bulk of those that had been felled were really barren. The fallen trunks, however, afforded an abundant harvest of ferns; while on the surrounding mountains, several of them quiescent volcanoes, which were higher than any I had yet visited, I was happy in gathering many shrubs and plants which I had not before seen. Close to my door grew one, our common ribgrass (*Plantago major*), which I would have passed by at home as a rank weed, but I gathered it here with real affection, as much "for auld acqua'ntance sake," as in sympathy with its distant exile and inexorable durance, with a few compatriots, on these unquiet peaks, which the hot surrounding plains have made an island-in-an-island prison, more hopeless to escape from than the most ocean-compassed speck. At 4500 feet above the sea I found a small species of *Hypericum* on wet ground, like our own Marsh St. John's-wort (*H. elodes*); here and there, about 5000 feet, appeared purple violets (*V. alata*), increasing in abundance with the ascent through woods of magnolias and chestnuts, their stems clothed with orchids, Freycinetias, climbing aroids and lycopods, and on whose floor the dreaded Upas dropped its fruits.

[9] *Cf.* MARKHAM's 'Travels in Peru and India.

Beneath the shady canopy of this tall fig no native will, if he knows it, dare to rest, nor will he pass between its stem and the wind, so strong is his belief in its evil influence.

In the centre of a tea estate not far off from my encampment stood, because no one could be found daring enough to cut it down, an immense specimen, which had long been a nuisance to the proprietor on account of the lightning every now and then striking off, to the damage of the shrubs below, large branches, which none of his servants could be induced to remove. One day, having been pitchforked together and burned, they were considered disposed of; but next morning the whole of his labourers in the adjacent village awoke, to their intense alarm, afflicted with a painful eruption, wherever their bodies were usually uncovered. It was then remembered that the smoke of the burning branches had been blown by the wind through the village; this undoubtedly accounted for the epidemic; but it did not allay their fears that they were all as good as dead men, for the potency of the sap as a poison is but too well known to them.

To prevent a general flight of the workmen it became necessary to get rid of the tree altogether, but the difficulty was to find any one willing to lay the axe to its root. At last a couple of Chinamen, after much persuasion and the offer of a high fee, agreed to perform the hazardous task of cutting up and carting it away. To the surprise of everybody they accomplished their task without experiencing the least harm. They pocketed their fee and departed in silence, without, however, saying that they had at intervals during their work, artfully smeared their bodies with cocoa-nut oil.

The sap of the bark alone is hurtful, for the logs into which the stripped trunk was cut were made into furniture for the owner's dining-room, without ill effects to the carpenters. The bark of another denizen of the same forest — *Gluta benghas*, one of the *Anacardiaceæ* — contains a sap even more noxious, for, falling on the skin, it produces stubborn ulcers which, on the wood-cutters — who often get splashed on their arms and body — require months to heal; but its sap is not used by them for poison, as the *antiarin* is. It is curious to reflect how acute native ingenuity has been in elaborating a pharmacopœia abounding in subtle articles to waste or take away life, while it contains hardly one to preserve it. The action of some of these preparations, whose effects I had heard of as well as seen, astonished me vastly, but no bribe that I could offer was tempting enough to induce their old *dukuns* to disclose their composition.

At elevations of 5000 feet *Podocarpus* trees (of the yew family), oaks and laurels formed much of the shade, under which flourished elegant *Melastomas*, with white instead of pink flowers, and raspberries (*Rubus*) of many kinds, the *Rubus lineatus*, a form with specially beautiful foliage, being abundant between 6000 and 7000 feet. On many of these mountains a single step would often lead the foot out of the green forest on to the edge of a great scar-like blotch, exuding sulphureous vapours through every crack and orifice, disfiguring their verdant slopes, like a suppurating sore on a fair neck. Yet within the indurated margins of these smouldering craters, a flora specially and surprisingly interesting is to be encountered. Amid the very vapours of the fumaroles I gathered bunches of Ericaceous flowers, such as *Gaultheria leucocarpa* and *punctata*, and *Vaccinium floribundum*, their leaves loaded with sulphur and other deposits, but their flowers stiff with healthy waxiness and fragrant with their own sweet honey odour; *Dipteris horsfieldi* and other ferns and plants, nowhere else to be seen on the mountain, grew in the steaming mud; while *Rhododendron retusum* stretched its roots out into the fuming streams, which boiled and bubbled over out of the rumbling cauldrons below.

The *Dipteris* fern is not found in Java much farther to the east. A line through the longitude of Samarang, which appears to be its eastern boundary, is also the western limit of the teak (*Tectona grandis*), of the camphor tree (*Dryobalanops camphora*), and of several species of palms (*Borassus flabelliformis*), and several species of *Caryota* and other trees, which are not found in West Java, though abundant in Sumatra. Mr. WALLACE has pointed out how much he found the Ornithology of the eastern to differ from that of the western portion of the island; and among mammalia, I am told by intelligent natives, neither the rhinoceros nor the Badger-headed Mydaus crosses this boundary eastward.

Outside the rim of the craters, where the ground had begun as it were to heal, broad patches of a beautiful species of lichen (*Cladonia vulcanica*) covered the surface, each tip of its pale grey thallus crowned with a fructifying scarlet disk. This is the lowly vegetation with which Nature, when a crater has become extinct, first slowly hides the wounds her strife has made, while scars made by landslips are concealed in a single season with a luxuriant covering of bananas.

During the rainy season the thunder of slopes laden with forest trees and shrubs crashing down, often for hundreds of feet into the valleys, was a daily sound, which impressed me with the supreme potency of rain as an agent in planing down the mountains and widening the valleys. I have often been astonished at the rapidity with which even a small stream will carry away the *débris* of a great landslip. When a heavy gale accompanies continued rains, the fall of giant trees on the narrowed ridges of mountains, is very often the cause of extensive landslips into both the adjacent valleys, which lowers down by very perceptible degrees their barrier ridges.

Among the more interesting zoological objects of this district added to my collection, were the *Siphia banjumas*, a fairy fly-catcher of a beautiful azure blue, whose nest, a thing of beauty like itself, I found cunningly concealed and protected by the curled edges of a *Rubus* leaf and containing a delicate, pure white egg dotted over with brownish-red spots; a sea-green magpie (*Cissa thalassina*), with brown wings, coral beak and legs; and a handsome shrike (*Laniellus leucogrammicus*), known only from Java. Civet-cats were very abundant; and the nocturnal scaly anteater or pangolin (*Manis*) was pretty often captured in the evening, while clumsily climbing on the trees, licking up with amazing rapidity streams of ants, which are its sole food — an interesting form especially to the embryologist and the genealogist, who find in its structures surviving "marks of ancientness," which have greatly helped to unravel the mammalian pedigree.

Another slow prowler, the *Mydaus meliceps*, very often made my evening hours quite unbearable by the intensely offensive odour with

which, even in its most inoffensive frame of mind, it hedged its crepuscular walks for at least a mile round. It was no use to try to frighten it away, for if its equanimity were disturbed it did not haste to his lair as one could have desired. It thickened, instead, the very air with a malignant scent that clung to one's garments, furniture and food for weeks. HORSFIELD has stated that it is exclusively confined to mountains rising over 7000 feet, "and that on these it occurs with the regularity of some plants extending from one end of the island to the other on the numerous disconnected summits." Its altitudinal distribution is, however, not nearly so restricted as here stated, for I have encountered it on hills and hot plateaus at all elevations down to below 500 feet above the sea; and it is said not to extend to East Java. The native has a superstition that if a man has fortitude enough to eat its flesh he will have become proof against sickness of all kinds.

In the forests on the southern slopes of the Malawar and the Wayang, the banteng (*Bos banteng*) lived in considerable herds. The full-grown animal has a magnificent head of horns, and I was very anxious to secure such a trophy; but only after the most wary and patient stalking was I able to get within range of a herd of them, and then only of a calf with immature horns. No more bellicose and dangerous inhabitant of the forest than a wounded bull need a hunter care to encounter.

The baying of troops of *Adjags* or wild dogs often reached my ears, but in all my efforts to meet them in full hunt I was disappointed. The native accounts — repeated to me in Sumatra a year later, in identically the same terms — of their manner of hunting credits them with so much intelligence, if not reason, that I was anxious to witness the performance for myself. Their food is chiefly the *Kantjil* and the *Muntjac* deer, and the natives in both countries averred that, on discovering a patch of alang-alang grass in which these are hiding, the adjags first urinate all the grass in a circle round their fugitives, then drive them out, when, blinded and maddened by the pain of the pungent urine in their eyes, they fall an easy prey to the dogs. They are so exceedingly shy and wary that it is difficult to secure a shot, and I obtained only a single specimen in bad condition. As soon as the fact became known I had quite a crowd beseeching for shreds of its skin, or if not that for a few hairs or some portion of its body, to suspend or to burn with a form of words near their rice-fields, as a charm to keep off evil influences from the crop. The whole of the carcase was cut up by them, distributed, and carefully carried away for this purpose!

Such forms of words are implicitly believed in, as I had an opportunity one day of learning from a dealer in krisses, who came to my house to trade. He was very anxious for me to buy a blade, and carefully showed me how to select one that would not fail me in time of need. To be a trusty weapon for me, it ought to be especially made to some measure of my own body — of hand, arm or thigh, of the breadth of my two thumbs or of my span; but to discover the same potency in a readymade blade, I ought to divide a straw or a grass-stem, of equal length with the blade, into as many lengths as it contains of its own breadth at a distance from the hilt of twice the measure of the first joint of the thumb. These pieces laid on the blade alternately lengthwise and crosswise would reveal the suitability of the weapon for my use, by the direction of the last piece — crosswise it would indicate a fence — "a bar sinister"; lengthwise, no obstruction — a favourable omen. Another test was to measure its length by the breadth of my right and left thumbs alternately, repeating at each alternation one of the words, "*Sri, Lungu, Dunia, Rara, Pati, Sri,*" &c., and according to which of these words should fall to the last thumb-breadth would the blade be for me a wise choice or not. *Sri* being a designation of honour, and *Dunia*, signifying the world, would therefore be good omens; whereas *Rara*, meaning sickness, and *Pati*, death, would indicate misfortune, and the purchase of such a kriss would bring me disaster. In much the same way, I can recollect how as boys we used to augur our destiny by the number of buttons on our garments — whether we were to become "a soldier, a sailor, a tinker, a tailor, a hangman, a lawyer or a thief."

In the beginning of May I left my bungalow on this salubrious plateau on my return to Buitenzorg. Everywhere the golden rice-fields were dotted with harvesters, their lacquered hats resplendent in blue and gold, the brown shoulders of the men and the scarlet calicoes of the women and children in the midst of the yellow grain, forming bright pictures in the sunny landscape all along the way.

After a few weeks in Buitenzorg and Batavia, spent in packing up and despatching my collections, I left for Telokbetong, in South Sumatra.

# ON VETERINARY SCIENCE AND PRACTICE IN THE NETHERLANDS INDIES

*by* J. FRICKERS, Vet.D.*

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The animal industries in the Netherlands Indies have been important since early colonial times. Before the Second World War there were approximately 700.000 horses, 4.500.000 oxen and cows, 3 250.000 carabaos, 5.900.000 goats, 1.900.000 sheep, and 1.300.000 swine.

The first veterinary college in the Netherlands had been opened in 1821. The year before, the Government of the Netherlands Indies had appointed for the first time a properly trained veterinarian. Since about 1893 veterinarians have been appointed much more frequently. In 1940 there were in the Netherlands Indies about 85 veterinarians, with academic background, mostly graduates of the Veterinary Faculty of Utrecht University. Of these about 73 were government officials (civil and military). Most of the veterinarians were natives of the Netherlands, though, especially in recent years, there have been quite a few Indonesians among them.

In addition to the veterinarians graduated from European universities and colleges, the government, already at an early date, endeavoured to train a number of veterinarians in the Indies. A small college for Indonesian veterinarians was established in Soerabaja in 1860. Because the results were not very satisfactory, it was closed in 1875. Afterwards Indonesian veterinarians were sometimes trained as assistants to government veterinarians, but the results were not very good.

In 1879 rinderpest caused serious conditions and the lack of a fair number of properly trained veterinarians was felt more than ever before. Yet it took quite some time and much discussion before a college for Indonesian veterinarians was established at Buitenzorg (in 1907). In the beginning the director of the Govt. Veterinary Research Institute was at the same time in charge of this college. In 1919 a director for the college only was appointed. New buildings were erected in 1928. In the beginning the college was part of the Department of Agriculture. In January 1934 the Veterinary College as well as the Research Institute were transferred to the Dept. of Economic Affairs. The following well-known scientists have acted successively as directors of the college: Dr. L. DE BLIECK, Dr. J. C. TH. SOHNS, Dr. H. J. SMIT, Dr. J. WITKAMP and Dr. J. MERKENS. There were about 50 students in 1930, 9 in 1936 (depression year) and 25 in 1940. The training usually took four years. In 1940 there were about 100 Indonesian veterinarians, trained by this college in the Netherlands Indies (about 85 of them in government positions).

The college not only trained veterinarians, but also Indonesian veterinary assistants ("veemantris," "veeoppassers"), inspectors for abattoirs, and horseshoers. There were about 200 veterinary assistants in the Indies in 1940. The special course which they pursued took about eight months.

The first European-trained veterinarians did not have it very easy. They lacked instruments, had only a few books, very little material on tropical problems, and mostly little opportunity for discussion with colleagues. A society for the promotion of veterinary science was established in 1884. A year later this society established a journal ("De Veeartsenijkundige Bladen van Nederlandsch-Indië," later changed into "Nederlandsch-Indische Bladen voor Diergeneeskunde en Dierenteelt," and more recently into "Nederlandsch-Indische Bladen voor Diergeneeskunde"). In 1941 volume 53 was in the course of publication. Most of the shorter scientific publications by Netherlands Indies veterinarians have been published in this journal. Several important publications have, however, been issued by the Department of Agriculture (later a branch of the Department of Economic Affairs). This Department issued annual reports of the Government Veterinary Service and published also a special serial, the "Veeartsenijkundige Mededeelingen." These publications did not deal with veterinary science and practice alone. Many articles on cattle breeding, management of herds, meat control, milk control, etc., have been published there.

The first veterinarians were occupied chiefly with the following three diseases: rinderpest, anthrax, foot- and mouth-disease. In addition there was a number of entirely unknown diseases. In the early years much veterinary research was done in medical laboratories, especially in Medan and in Batavia (Weltevreden). Some forty years ago the Government veterinarian J. K. F. DE DOES was appointed as a liaison officer in the Weltevreden Laboratory. In 1907, however, thanks to his reports, a Veterinary Research Laboratory was established in Buitenzorg.

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* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."* — *Cf.* also Dr. BAKKER's account on p. 1–4. — For an interesting veterinary travelogue *see* F. L. HUBER, [illegible], *n. d.* (Veeartsenijk. Meded. 74, pp. 45).

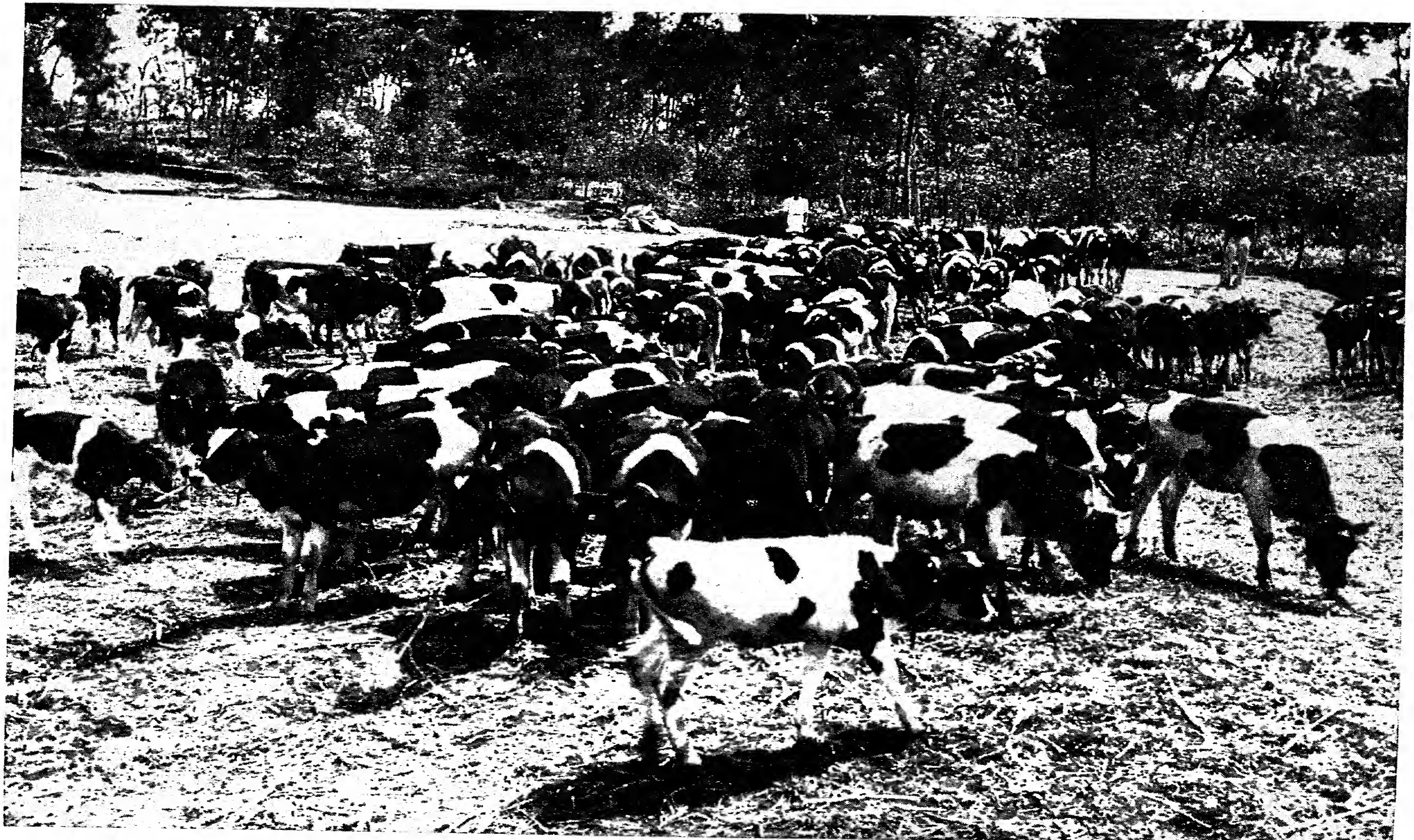


FIGURE 27. — A HERD OF HOLSTEIN CATTLE ON A FARM NEAR BANDOENG (WEST JAVA).

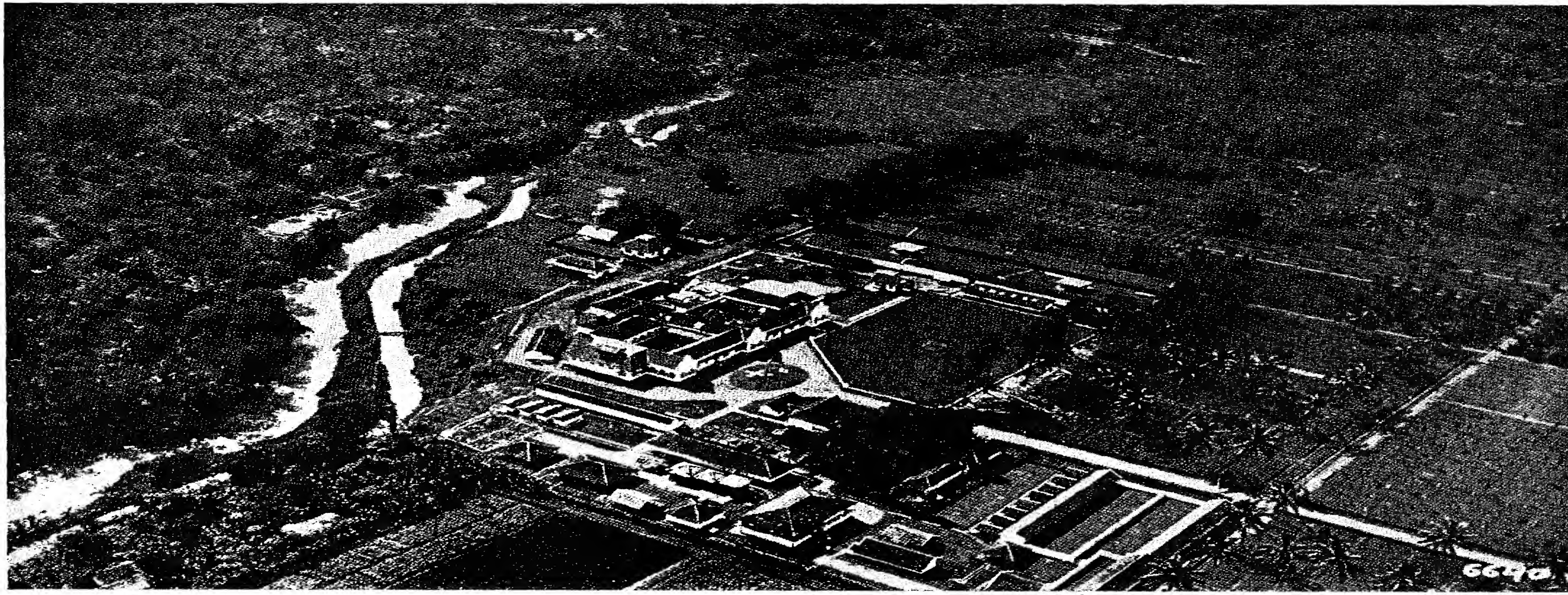



FIGURE 28. — A VIEW OF THE VETERINARY RESEARCH INSTITUTE AT BUITENZORG.

As it so often happens, important work had been done before this well-equipped laboratory was opened. Dr. C. EIJKMAN's discovery that polyneuritis in birds is nothing but an avitaminosis may be recalled. VAN ECK discovered the cause of septicemia of the carabao. He is also known for his work on glanders and sarcosporidiosis. DE DOES has done important work in several fields: on lymphangitis epizootica of horses, surra, piroplasmosis, osteomyelitis of carabaos, filariasis of horses and cattle.

At the time the Veterinary Laboratory was established DE DOES fell ill and could not continue his splendid work. Dr. L. DE BLIECK was appointed director in 1908. In the first place, the members of the staff occupied themselves with research on various diseases and their therapy. In the second place the institute was responsible for the preparation of sera, vaccines and diagnostic agents. In 1909 mallein, tuberculin, sera and vaccines in the campaign against hemorrhagic septicemia and anthrax were prepared extensively. In 1940 the institute prepared mallein, tuberculin (for subcutaneous, ophthalmic and intradermal reactions), septicemia serum and vaccines, anthrax serum and vaccines, sarcophysema gangraenosum bovis serum and vaccine, vaccines for infectious abortion of cattle, avian diphtheria (roup) and epithelioma contagiosum vaccines and dried inoculum, coli-bacillosis serum and vaccines, etc.

The institute has 5 sections, each with its departmental head: —

1. *Div. for general diagnostics* (3,000–4,000 cases a year).
2. *Div. for serodiagnostics and chronic infection diseases* (about 30,000 samples are received a year from everywhere in the Indies, about 50,000 tests are made, especially for glanders, brucellosis, anthrax and animal protein).
3. *Div. of sera and vaccines.*
4. *Div. of poultry diseases* (this was discontinued in 1933, though other departments continued to give much attention to the numerous interesting diseases of poultry which occur in the Indies).
5. *Zoological dept.* — Chiefly concerned with the identification and study of the biology of various parasites.

Of recent members of the staff and their activities it may be of interest to report the following data: —

Dr. L. DE BLIECK was especially concerned with piroplasmosis, glanders, etc.

Dr. B. BUBBERMAN and Dr. F. C. KRANEVELD did much work on a common skin disease of cattle ("cascado"). This disease had been studied by DE DOES who called it "dermatitis verminosa prariëns bovis." It appeared that it was caused by a nematode (*Stephanofilaria dedoesi* Ihle). The same disease has later been found in the U.S.A. by Dr. G. DIKMANS.

Dr. BUBBERMAN is also known for his work on surra, trichomoniasis, etc.

Dr. L. W. M. LOBEL discovered the cause of a skin disease of buffaloes characterized by small tumors ("huidknobbelziekte"). This appeared to be caused by certain microorganisms, closely related with "lepra tuberosa" of man. The disease is now well understood and known under the name "lepra bubalorum." Other researches of Dr. LOBEL dealt with tuberculosis in cattle, brucellosis, glanders, etc.

Dr. F. C. KRANEVELD, often in coöperation with F. L. HUBER and Raden DJAENOEDIN, specialized in studies of anaerobic bacteria. He is especially known for his work on "osteomyelitis bacillosis bubalorum," has written also on colibacillosis (calf), *Trypanosoma theileri*, surra, pseudo-fowlpest, salmonellosis, trichomoniasis, etc.

Dr. W. K. PICARD did much work on bird diseases.

Dr. B. J. KRIJGSMAN made a special study of the parasites of mammalia and birds. He is especially known for his work on ticks. A short time before the Japanese invasion many ticks were sent to Dr. J. C. BEQUAERT of Harvard University in Cambridge. Dr. F. C. KRANEVELD and Dr. J. B. DOUWES also did much useful work in parasitology.

Drs. NIESCHULTZ and KRIJGSMAN are the authors of a series of remarkable papers on parasitic and disease-carrying insects.

Mention should also be made of Dr. F. L. HUBER's work on hemorrhagic septicemia. During recent years vaccinations against this disease were offered on a very large scale, throughout the Indies, every half year. The results were very satisfactory. HUBER also worked on anthrax, colpitis granulosa, blackleg, para-blackleg, etc.

# MISSIONARY PHYSICIANS AND HOSPITALS IN THE NETHERLANDS INDIES

*by*

K. P. GROOT, M.D.*

Extensive missionary work of a religious nature started in many parts of the Netherlands East Indies in the earlier years of the nineteenth century. These pioneer missionaries, working in a primitive society, prided themselves on being specialists in many fields. They were not only preachers but acted simultaneously as linguists, teachers, architects, agricultural advisors, and not too seldom as physicians or even as obstetricians. Creditable as their efforts were, the missionary societies felt the needs for well-trained medical missionaries. In the Netherlands Indies the purely medical mission developed only recently. By the middle of the last century dozens of missionary hospitals had been established in British India and in China, where hundreds of physicians worked as missionary physicians. However, in the Netherlands Indies the first missionary physician, Dr. J. C. SCHEURER, did not land until 1893. He located himself in Djokjakarta in middle Java. Shortly afterwards, a second missionary doctor, Dr. H. BERVOETS, took up his residence in Modjowarno in eastern Java. In Modjowarno BERVOETS found a reasonably well-equipped auxiliary hospital, where a young missionary acting as medical supervisor, was assisted by a few private physicians living in the neighborhood. Pupils of the mission schools were used as male and female probationers in the hospital. The missionaries had prepared the population so well that the Indonesians around Modjowarno were already looking up to Western Medicine.

In Djokjakarta conditions were different. Here, the number of Indonesian Christians was only small. General education had hardly started, and nurse-maids, young gardeners and such unskilled labor formed the material which had to be trained as hospital attendants. For

* Based on an account by Dr. K. P. GROOT *in Geneeskundig Tijdschrift voor Nederlandsch-Indië, Feestbundel* 1936, pp. 235–245, translated by Mrs. J. A. C. FAGGINGER AUER of Belmont, Mass., abridged and annotated by Dr. I. SNAPPER.

years, adults were educated for this task of nurses' aides by simple methods in a special school. It seems that Dr. SCHEURER, a competent judge of human nature, intuitively chose the right people as nurses' aides, and among the older hospital attendants, selected in this way, were many persons with great devotion who did important work for the propaganda of Western Medicine. Conditions in middle Java were hardly favorable for the spread of medicine into the country districts. SCHEURER went out every afternoon to visit the patients in the surrounding villages and hamlets. In the beginning he had great difficulty in convincing even seriously ill patients to come to his missionary hospital. Gradually SCHEURER's influence upon the population grew and in later years home visits by missionaries could be abandoned except in the case of obstetrics. Nowadays, the flow of patients to the Dispensaries is so considerable that the medical personnel could not be burdened anymore with these time-consuming home visits.

In eastern and middle Java, as in other tropical areas, the outstanding success of neoarsphenamine treatment for syphilis and especially for yaws has been one of the main reasons why in the long run Western medical science has become popular with the population. In this initial period obstetrics were a sore point. Aid for deliveries was called for only in hopeless cases. The treatment of such neglected obstetrical patients had usually only poor results. This in its turn seemed to confirm the opinion of the population that Western Medicine was of little value. In the first ten years only 50 obstetrical cases could be treated, in the next ten years this number increased to 200, in the third decade to 500. Then the ice was broken and in the next ten years about 1,500 obstetrical cases were yearly attended to.

In 1906 SCHEURER had to return to the Netherlands because his heart was affected by beri beri. His successor was Dr. H. S. PRUYS. He had already practiced for eleven years as a military physician in the East Indies when in 1906 he came to Djokjakarta as successor to Dr. SCHEURER. The hospital then had about 150 beds. The number of patients yearly admitted was highly satisfactory and the personnel was relatively well trained. PRUYS felt very keenly that a hospital even with several hundreds of beds cannot take care of a district such as Djokjakarta with one and a half million inhabitants of whom a large part live at distances of 30 miles and more from the hospital. He, therefore, decided to bring medical science to the villages. He decentralized medical care by building auxiliary hospitals of about 50 beds. Here malaria, tropical ulcers, trachoma, yaws and venereal diseases could be dealt with, whereas the more serious cases were passed on to the Central Missionary Hospital. At the head of these auxiliary hospitals PRUYS placed his hospital trained attendants who had worked for a number of years in the main hospital. These attendants were able to recognize malaria in blood smears, worm diseases in stool specimens, etc. PRUYS trusted their clinical experience to the extent that they were deemed able to recognize the serious cases which had to be transferred to the hospital. These auxiliary hospitals were built on good roads, were connected by telephone with the central hospital, and had an ambulance for the transportation of patients at their disposal. These plans of PRUYS have been further developed and nowadays a group of eleven auxiliary missionary hospitals and five missionary dispensaries are situated in a radius of thirty miles around the main missionary hospital in Djokjakarta. Lately, several of the more remote auxiliary hospitals have been headed by Indonesian physicians who take care of their own hospital, of three dispensaries and of one other nearby auxiliary hospital. The auxiliary hospital has an operating room and also treats difficult obstetrical problems which can not be handled by a midwife. Finally, an excellent sanitarium for the treatment of patients with lung tuberculosis (Kalioerang) has been built by the missionary society near Djokjakarta on the slopes of the Merapi mountain.

This so-called Djokajarta system has been accepted for many other missionary hospitals in the Netherlands East Indies, as for instance, in Modjowarno, Poerwodadi, Solo, and Bandoeng.

The missionary hospitals have been very strict about income which their physicians might derive from private practice. Often it has been advocated that the fees which the missionary physician collected from private patients, should be divided between the hospital and the physician. PRUYS had always fought against this system. Thanks to his influence, everywhere in the Netherlands Indies the missionary physicians give up all earnings derived from private practice to their hospitals

In the beginning autopsies could not be made in the mission hospitals, although at that time in the military hospitals and the large estate hospitals of the plantations in Deli on Sumatra's east coast, much important scientific work was performed in the autopsy rooms. In later years, this prejudice has been overcome in the missionary hospitals and nowadays autopsies are regularly performed.

The other pioneer missionary in the Netherlands Indies, Dr. BERVOETS was able to continue his work as a missionary physician for almost 40 years, first in Modjowarno, later in Margoredjo and Kelet. He not only organized or founded these three hospitals but he started a very useful organization, the S.I.M.A.V.I. (Medical Care for the Indonesian Population) which became of great importance for the medical work in this territory. He died, still active, in 1933. He wrote a textbook on obstetrics in the Javanese language which never appeared in print. However, in 1934, Dr. A. P. KETEL of the Modjowarno mission hospital published such a textbook, using the old notes of Dr. BERVOETS. PRUYS wrote a textbook of nursing which, for years, was of great value to missionary physicians who were to train their own personnel.

Originally the missionary hospitals were built and maintained entirely without government aid. Gradually the Government Public Health Service appreciated the efforts of the medical missionaries so much that the missionary hospitals received from the Public Health Service considerable grants of drugs and surgical dressings, and later also financial contributions. In 1906 the matter of subsidies to missionary hospitals was fixed by government regulation, and in 1928 these regulations were revised. Since then 60 to 70 per cent of the expenses for the missionary hospitals are covered by government subsidies. In 1909 there were five missionary hospitals in the Netherlands Indies, in Modjowarno, in Djokjakarta, in Margoredjo and in Poerwodadi in Java and in Pearadja in Sumatra, together

with six auxiliary hospitals, and four Out-Patient Departments, with a total of 940 beds. In these hospitals worked eight European physicians and one Indonesian physician. In 1924, there were 13 central missionary hospitals with 44 auxiliary hospitals, and one leper hospital with a total of 3,258 beds. In these hospitals 27 European and 3 Indonesian physicians were working. This extension took place almost entirely in Java. In 1934 there were 27 main missionary hospitals with 57 auxiliary hospitals, 5 leper hospitals and one missionary sanitarium for lung tuberculosis with a total of 7,085 beds.[1]

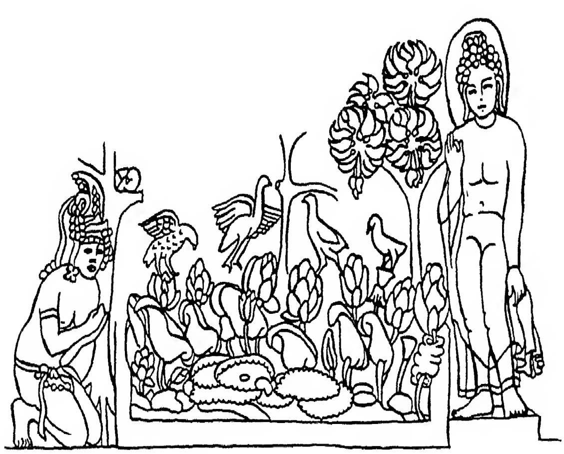
A considerable part of this increase was due to missionary settlements outside of Java. In Sumatra the first missionary hospital was set up in 1900 in Pearadja. In 1926 another hospital was opened in Balige on Lake Toba in northern Sumatra. In 1934 there were missionary hospitals not only in Java and Sumatra, but also in Borneo, Celebes, Halmaheira, New Guinea, Soemba Island, and the Sangir and Talau Islands. The total number of missionary physicians was then 62, of whom about 25 per cent were Indonesians or Chinese.[2]

[1] Total number of hospital beds in the Netherlands Indies amounted to about 60,000.

[2] The total number of physicians in the Netherlands Indies was about 1,100.

Gradually, the training of the medical personnel of the missionary hospitals has been modified and improved so that it now conforms to the regulations of the Government Public Health Service. Female and male nurses and midwives trained in missionary hospitals all have to pass the government examinations. The general conditions in the missionary hospitals have also improved steadily. Nowadays, a good deal of the European population requests admission to the missionary hospitals. Originally these hospitals were especially built for the Indonesian population, but now, some of the missionary hospitals have also constructed private wards.

For a long time the activity of the missionary hospitals concentrated mainly on practical medical care and nursing care for patients. There was no opportunity and no time for research. Lately, this also has changed. The missionary hospitals are now working in close connection with the medical schools in Java and other medical scientific institutions, as for instance, the Cancer Institute in Bandoeng. The appointment of new staff members with excellent scientific records guarantees that in the future, also in the missionary hospitals of the Netherlands Indies, a good deal of scientific work will be done.



*In Memory of P. V. van Stein Callenfels*

# PREHISTORIC RESEARCH IN THE NETHERLANDS INDIES

*by*

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## I. THE BEGINNINGS

G. E. RUMPHIUS, who in the second half of the 17th century laid the foundations of botanical and zoological research in the East Indies, was also the first European scholar ever to take an interest in prehistoric objects of that region.

In his "Amboinsche Rariteitkamer," he devoted one chapter to stone and one chapter to bronze axes. Although he was puzzled by the similarity of these objects to man-made tools, he was not able to rid himself of the popular belief of his age, according to which they were thunderbolts. He tried to give a scientific explanation, assuming that they originated in the clouds from terrestrial evaporations, transformed into stone or metal by the power of lightning. In spite of these fundamental errors, his descriptions and illustrations and the report he gives of the native folk-lore about the alleged thunderbolts are of value even today (1).

It was a century and a half before the prehistoric tools of the Archipelago were again given some attention. Beginning in 1849, the Dutch physician and anthropologist, CORNELIS SWAVING, sent several collections of neolithic adzes from Java to Holland (2). In 1850 he published a few such adzes, then in the museum of the Batavian Society of Arts and Letters (3). In 1850 C. LEEMANS, Director of the Museum of Antiquities at Leyden, Holland, gave for the first time a systematic survey of the various types, known at that time, of stone implements from the East Indies. His digest was based on the collections sent to Leyden by SWAVING and others (4). A similar task was performed by J. J. VAN LIMBURG BROUWER for the prehistoric collections of the Batavian museum in 1872 (5). In 1887 C. M. PLEYTE summarized the knowledge of his time about the stone age of Indonesia (6). This knowledge was, as yet, confined exclusively to neolithic axes and adzes, all of them accidental finds. However, PLEYTE's classification of the various types and of their geographical distribution proved of considerable value, and four decades later, served as a basis for VAN STEIN CALLENFELS' and my own geographical and chronological analysis of the Neolithic of the Archipelago.

Various notes on prehistoric stone and bronze objects published in the Notulen of the Batavian Society of Arts and Letters and in several Dutch, German and French periodicals during the latter half of the 19th century are on the whole of little importance. Only one class of prehistoric objects from Indonesia, the large bronze drums, began to attract considerable interest during the latter part of the 19th century and became the subject of systematic research and of several valuable publications (7).

Towards the end of what we may call the first period of prehistoric research in the East Indies, DUBOIS' spectacular discovery of the *Pithecanthropus* fragments suddenly brought Java into the limelight and aroused expectations which were to be fulfilled only forty years later by the researches of R. VON KOENIGSWALD (8).

The beginning of the second period of prehistoric research in Indonesia is marked by the first systematic excavation of a prehistoric site ever to be undertaken in the Archipelago; it was that of the Toala caves in Southwest Celebes by PAUL and FRITZ SARASIN in 1902. It revealed for the first time the existence of a culture of predominantly late palaeolithic (mesolithic) character

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* *Prepared for "Science and Scientists in the Netherlands Indies"*, as part of the research program conducted in 1944 by the East Indies Institute of America. Details about the work of the East Indies Institute are given in the appendix to this volume.

(9). During the following two decades our knowledge of the Stone Age was enlarged by the publication of various accidental finds from Sumatra, Celebes and Borneo (10). As far as the Bronze Age is concerned, van der Sande published some finds from Lake Sentani in New Guinea; van Hoëvell, Schmeltz, Nieuwenkamp and Hazeu described some of the more important bronze drums; Meyer and Richter contributed a treatise on the Bronze Age of Celebes; and Foy and Rouffaer one each on bronze drums which, however, were at that time not yet known to date from the Bronze Age (11). The prehistoric collections of the Leyden Museum were made more accessible by the publication of a catalogue (12). On the whole, very little progress was made. Only one more site, a cave in Sumatra, was more or less systematically excavated (13). Mrs. Lenore Selenka's expedition to Trinil, in Java, although rich in geological and palaeontological results, failed in its chief aim, that of discovering further remains of *Pithecanthropus* (14).

By far the most important contribution to Indonesian prehistory during this period was Dubois' publication on two Proto-Australoid skulls which had been discovered at Wadjak, Java, thirty years before (15). The end of the period is marked in 1923 by the first attempt to give a comprehensive survey of what was then known of Indonesian prehistory, and to correlate the latter with that of continental Southeast Asia (16).

## II. Development of Systematic Research

**Research on Mesolithic and Early Neolithic Cultures.** — Around the middle of the 1920's, the intermittent and somewhat erratic activities hitherto devoted to the prehistory of Indonesia at last began to develop into more systematic research. This is largely due to the work of P. V. van Stein Callenfels. His interest in prehistory had first been aroused in 1920 when, during a tour of inspection for the Archaeological Service, the shell heaps near Medan in Sumatra were pointed out to him (17). In 1924 he made known the first hand-ax of late palaeolithic (mesolithic) type from Indonesia, ever to be described (18).

In 1926 J. C. van Es discovered the prehistoric site in the Goewa Lawa (Bat Cave) near Sampoeng in Java, and began some preliminary excavations (19). It was systematically explored by van Stein Callenfels in the years 1928 to 1931 — the first scientific excavation of a prehistoric site ever to be carried out in Java (20). It yielded two hitherto completely unknown cultures: a neolithic culture with stone arrow heads in the lowest stratum, and above this a culture with tools of bone, deer horn and mussel shell which, although it contains neolithic elements, seems to be essentially of mesolithic character (fig. 29). Similar finds were made in caves near Bodjonegoro. The human remains from these sites were studied by W. A. Mijsberg (21).

Since 1926 excavations as well as systematic collection of surface finds have multiplied. It is mainly our knowledge of the mesolithic and early neolithic cultures that has profited from these investigations.

The term Mesolithic, as used here, calls for some explanation. It does not imply that the cultures in question form a link within a genetic line leading from the Palaeolithic to the Neolithic. No such development has taken place in Indonesia. The mesolithic cultures of Indonesia are really late palaeolithic cultures which flourished during the first millennia of the present geological period. However, during their later phases they were more or less affected and transformed by neolithic influences coming in from the North. As a result, no clear-cut line exists here between Late Palaeolithic and Early Neolithic, and it is in this sense that we may call the cultures of this period mesolithic.

The mesolithic hand-ax cultures of Sumatra (fig. 30), known from shell-heaps on the Northeast coast of the island and from numerous surface finds, formed the subject of a number of excavations and studies (22). Traces of similar or related cultures were discovered also in Java (fig. 31) (23), Borneo (24) and Celebes (25). In Borneo, remnants of this cultural group had been found more than forty years ago, but at that time nobody had recognized their real significance. All these cultures proved to be more or less closely related to the Hoabinhian and Bacsonian cultures of French Indo-China and of the Malay Peninsula. Like the Hoabinhian and Bacsonian, they appear in two phases, an earlier one of purely palaeolithic aspect, and a later one which was already affected by neolithic influences, as proved by traces of primitive stone grinding and occasionally even by the presence of pottery. The interconnections and the distribution of this whole cultural group over wide areas of French Indo-China, the Malay Peninsula, Indonesia, the Philippines and Japan have been discussed by van Stein Callenfels and by the author (26). To this may be added that the American Museum of Natural History possesses stone implements of characteristic Hoabinhian and Sumatra type, found by N. C. Nelson in the Yangtze gorges of western China. On the other hand, it has been shown that the mesolithic hand-ax cultures have spread from Indonesia to Australia (27).

A few fragments of skulls, hardly sufficient for a final racial determination, were found in one of the shell-heaps of North Sumatra. These were studied by Wastl, who came to the conclusion that they showed Papua-Melanesoid racial characters (28). This conforms very well with conditions in French Indo-China and on the Malay Peninsula, where a considerable part of the human remains found at sites of mesolithic hand-ax cultures belong to the Papua-Melanesoid racial group. Indeed, it seems probable that at least part of the peoples who introduced the Bacson-Hoabinhian cultures in Indonesia were the ancestors of the present day Papuans and Melanesians. However, this does not justify replacing the term Hoabinhian (or Bacson-Hoabinhian, as I prefer to call the whole cultural group) by that of Melanesoid Culture, as van Stein Callenfels suggested (29). This suggestion, which was, at the very least, premature and, moreover, ambiguous, has been rightly criticized and rejected by Collings, Evans and McCarthy (30).

The so-called Toalian culture of Southwest Celebes was already known by the excavations carried out by the cousins Sarasin in the beginning of this century (31). It derives its name from the fact that it was first discovered in caves around Lamontjong, some of which were at that time still inhabited by the Toala, the remnant of a primitive tribe, whom the Sarasins considered to be the direct descendants of the ancient stone age people. The Toalian is essentially a flake

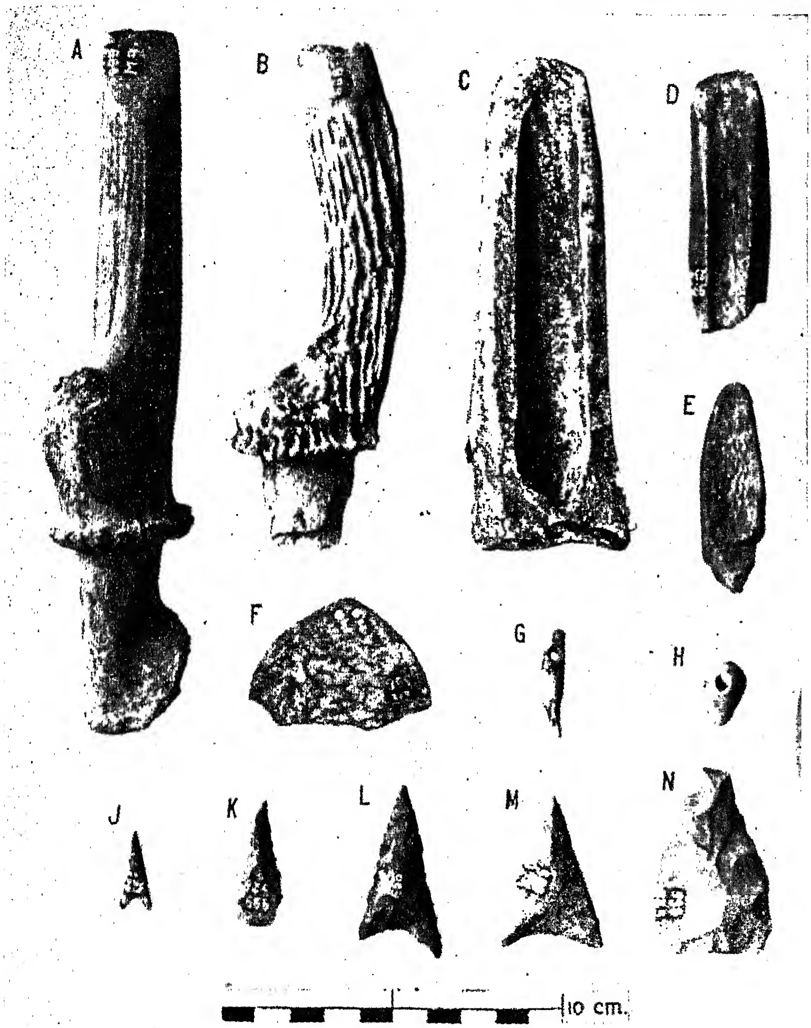


FIGURE 29. — OBJECTS FROM THE GOEWA LAWA (BAT CAVE) NEAR SAMPOENG, JAVA. A and B: Implements of deerhorn. C to E: Implements of bone. F to H: Ornaments of nacre (F), tooth (G) and shell (H). J to N: Stone arrowheads. — Museum of the Koninkl. Bataviaasch Genootschap van Kunsten en Wetenschappen. (*From* VAN DER HOOP, 1941b.)

culture of late palaeolithic character which, however, contains some neolithic elements, above all, stone arrow heads of neolithic character. In recent years, VAN STEIN CALLENFELS, VAN HEEKEREN and WILLEMS excavated Toalian sites in various regions of Southwest Celebes. Moreover, they discovered an earlier, purely palaeolithic phase of this culture, the Proto-Toalian. The results of these excavations have so far been published only in part (FIGS. 32, 33) (32).

Mesolithic flake cultures related to the Proto-Toalian were discovered by VAN HEEKEREN in caves of East Java and by ALFRED BÜHLER on the small island of Roti (33). A culture of a somewhat unique character, discovered by BÜHLER in rock-shelters of Timor, may perhaps be considered as an early Neolithic, developed on the basis of a branch of the Proto-Toalian (FIG. 34) (34).

The existence of a flake culture of a different kind, a culture which used almost exclusively obsidian as material for its tools, had already been revealed by the excavations carried out by a Swiss geologist, AUGUST TOBLER, in the cave Ulu Tjanko in Upper Djambi, Sumatra (35). A second cave containing remains of the same culture was excavated by J. ZWIERZYCKI in Upper Djambi, while A. VAN DER HOOP collected numerous obsidian tools and flakes on the surface near Lake Kerintji in Central Sumatra. Similar artifacts were also found in the region of Palembang and in the Lampong Districts of South Sumatra (36). Some of these obsidian artifacts are so small that they may be designated as microliths. This microlithic element is even more marked among the numerous obsidian tools and flakes collected by VON KOENIGSWALD in the surroundings of Bandoeng in West Java (FIG. 35) (37).

VAN STEIN CALLENFELS, VON KOENIGSWALD and VAN DER HOOP classified this obsidian culture

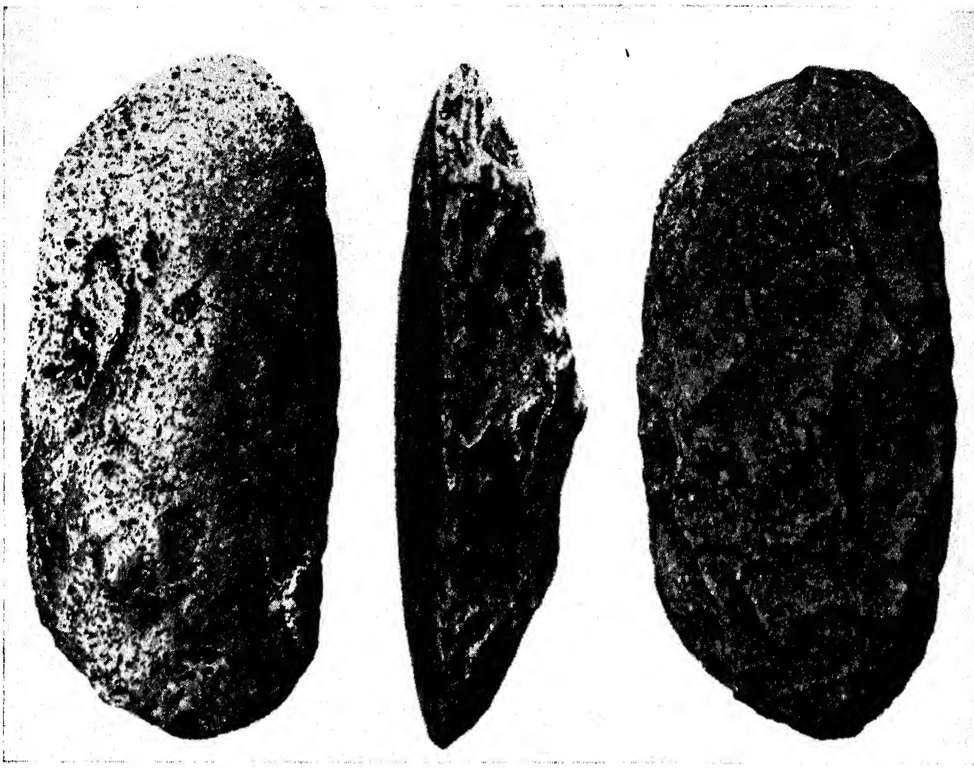

FIGURE 30. — MESOLITHIC IMPLEMENT OF "SUMATRA TYPE," GUNUNG PONDOK, PERAK, MALAYA. In tools of this kind only one side of the pebble has been chipped (*right*), whereas the other side retains the original smooth surface (*left*). The type is found in French Indo-China, Malaya and other areas of Southeast Asia and is especially frequent in Sumatra. (*From* OV 1926.)

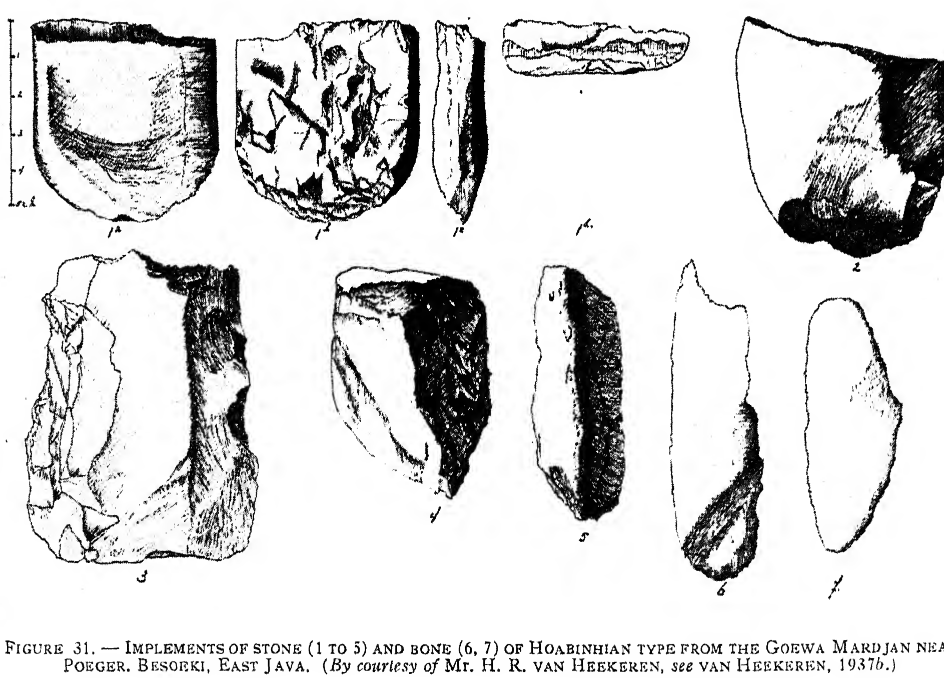

FIGURE 31. — IMPLEMENTS OF STONE (1 TO 5) AND BONE (6, 7) OF HOABINHIAN TYPE FROM THE GOEWA MARDJAN NEAR POEGER, BESOEKI, EAST JAVA. (*By courtesy of* Mr. H. R. VAN HEEKEREN, *see* VAN HEEKEREN, 1937*b*.)

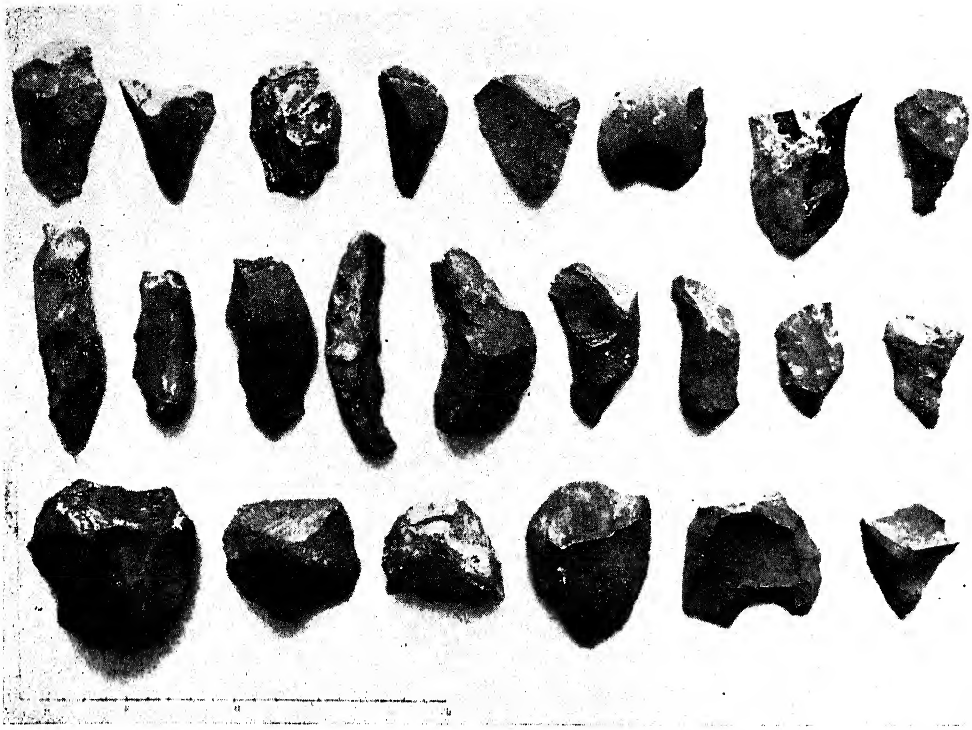

FIGURE 32. — STONE IMPLEMENTS FROM THE LIANG KARRASSA (GHOST CAVE) NEAR MAROS, SOUTHWEST CELEBES. (*By courtesy of* MR. H. R. VAN HEEKEREN, *see* VAN HEEKEREN, 1937–38.)

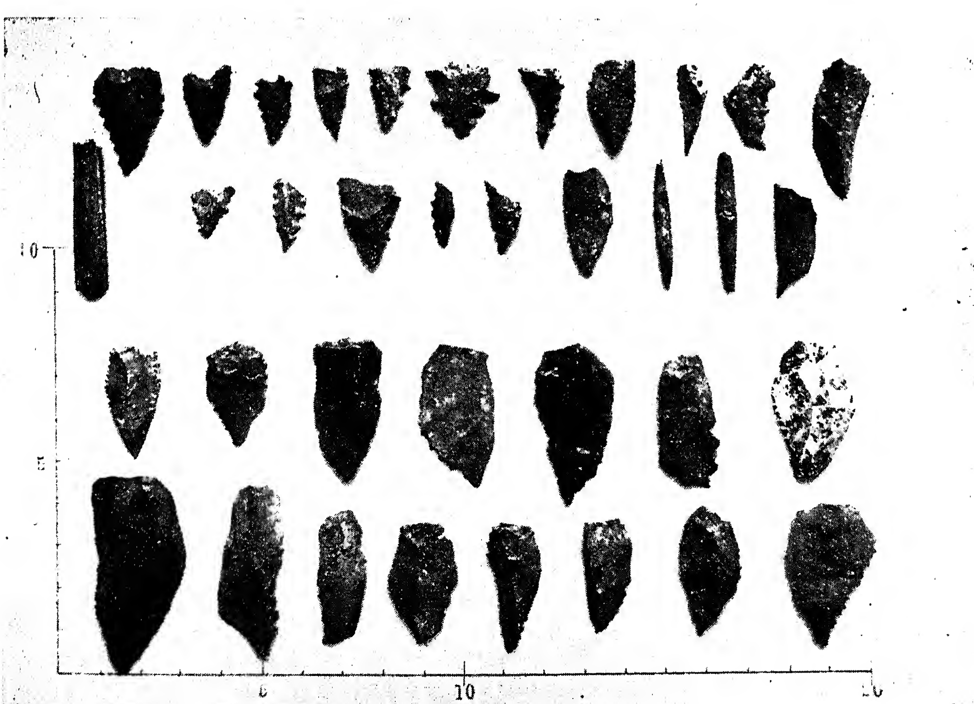


FIGURE 33. — *Two upper rows:* ARROW HEADS OF STONE AND BONE (second row, first to third from right) AND FRAGMENT OF A RAY-STING (second row, first from left), ARA, SOUTHWEST CELEBES. *Two lower rows:* STONE IMPLEMENTS FROM THE LIANG KARRASSA NEAR MAROS, SOUTHWEST CELEBES. (*By courtesy of* MR. H. R. VAN HEEKEREN, *see* VAN HEEKEREN, 1937*a* and 1937–38.)

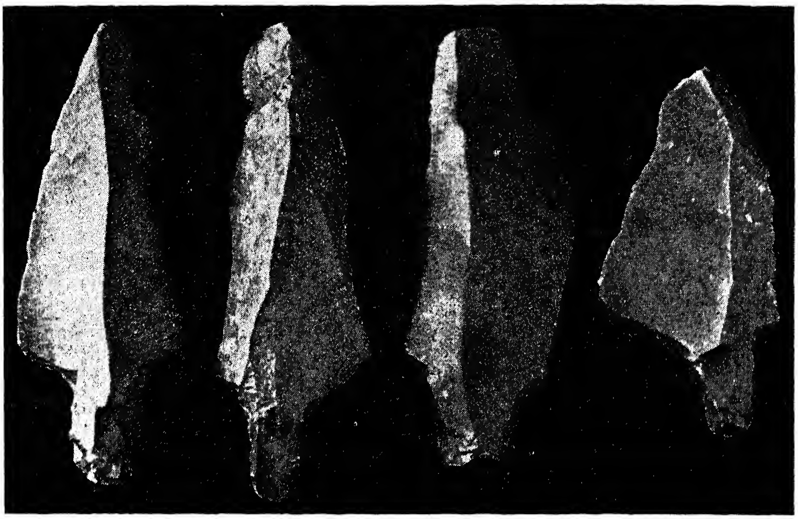

FIGURE 34. — STONE POINTS, TIMOR. (*From* FRITZ SARASIN, 1936.)

as neolithic. It is possible that they may be right. However, their arguments are not convincing, and until proofs to the contrary are brought forward, it seems more plausible to class the obsidian cultures of Sumatra and Java as mesolithic cultures of Late Palaeolithic character. The microliths collected on the surface near Leuwiliang in the Residency Buitenzorg, West Java, may probably be ascribed to the same culture as those from Sumatra and Bandoeng, although at this site obsidian was used to a lesser extent than other kinds of stone (38).

In 1938 W. WILLEMS excavated several caves in the region of Toeban near the North Coast of East Java. He found neolithic stone arrow heads and tools of bone similar to those previously discovered by VAN STEIN CALLENFELS in the Goewa Lawa near Sampoeng. Whereas in the latter, arrow heads and bone implements belonged to different horizons, both occurred together in the same strata in the Toeban caves. Moreover, the cave culture of Toeban was characterized by an enormous number of tools made from mussel shell, similar to those found at some Toalian sites in Southwest Celebes and in a cave in the region of Djember in East Java (39). Since no detailed report has so far been published, it is not yet possible to draw conclusions about the character and chronological position of the Toeban culture.

**Research on the Neolithic of Indonesia:** — Whereas in recent years considerable advance has been made in our knowledge of mesolithic and mixed mesolithic-early neolithic cultures, the excavations listed above having revealed a substantial part of the material equipment and mode of life of the ancient cave dwellers, the same cannot be said with regard to the full Neolithic. The reasons for this are obvious. The hunters and food-gatherers of the Mesolithic Period lived largely, though certainly not exclusively, in caves and rock-shelters. As a result, it is relatively easy to locate at least some of their dwelling sites. On the other hand, the agriculturists of the full Neolithic lived in villages, the sites of which can in general be found only accidentally. So far, no neolithic site corresponding to the famous mound of Samrong-sen in Cambodia has been discovered in Indonesia.

Nevertheless, it is my impression that some more systematic research might have been done on this subject. Thus, FRANSSEN has indicated a site at Tjidjahe, near Buitenzorg, which might possibly be that of a neolithic dwelling place, although it may have been merely a workshop (40). OPPENOORTH speaks of a site near Getas in Central Java, where many skulls of pigs and dogs, as well as a human skull, have been found (41). This might indicate the place of a neolithic village. However, even if the site should date from the Bronze Age or from the Hindu period, it would well repay systematic investigation. As far as I know, only one attempt has been made to excavate a neolithic dwelling site in Java, at Toegoe in the Residency Kedoe. However, only some sherds and stone flakes were found and the excavation was soon discontinued (42).

What may possibly have been the site of a neolithic dwelling place was excavated by VAN STEIN CALLENFELS near Galoempang in western Central Celebes. He found stone tools belonging to a branch of the mesolithic hand-ax culture, as well as objects of full or even late neolithic character: quadrangular adzes, tanged axes resembling those of Indo-China and of the region of Hongkong, rough "violin-shaped" stone tools resembling those of the Neolithic of Japan, and polished stone arrow-heads obviously related to those of the Neolithic (and perhaps of the Bronze Age, too) of China, Manchuria and Japan (FIG. 36) (43). The finds from Galoempang are thus of great importance, as they indicate connections between the neolithic culture of eastern Indonesia and the Neolithic of Japan and southern China. On the other hand, the tanged stone adzes of eastern Polynesia resemble those of Celebes, thus possibly indicating the point of departure in the East Indian Archipelago of one of the Polynesian migrations (44). It is the more regrettable that the results of VAN STEIN CALLENFELS' excavations at Galoempáng have never been published

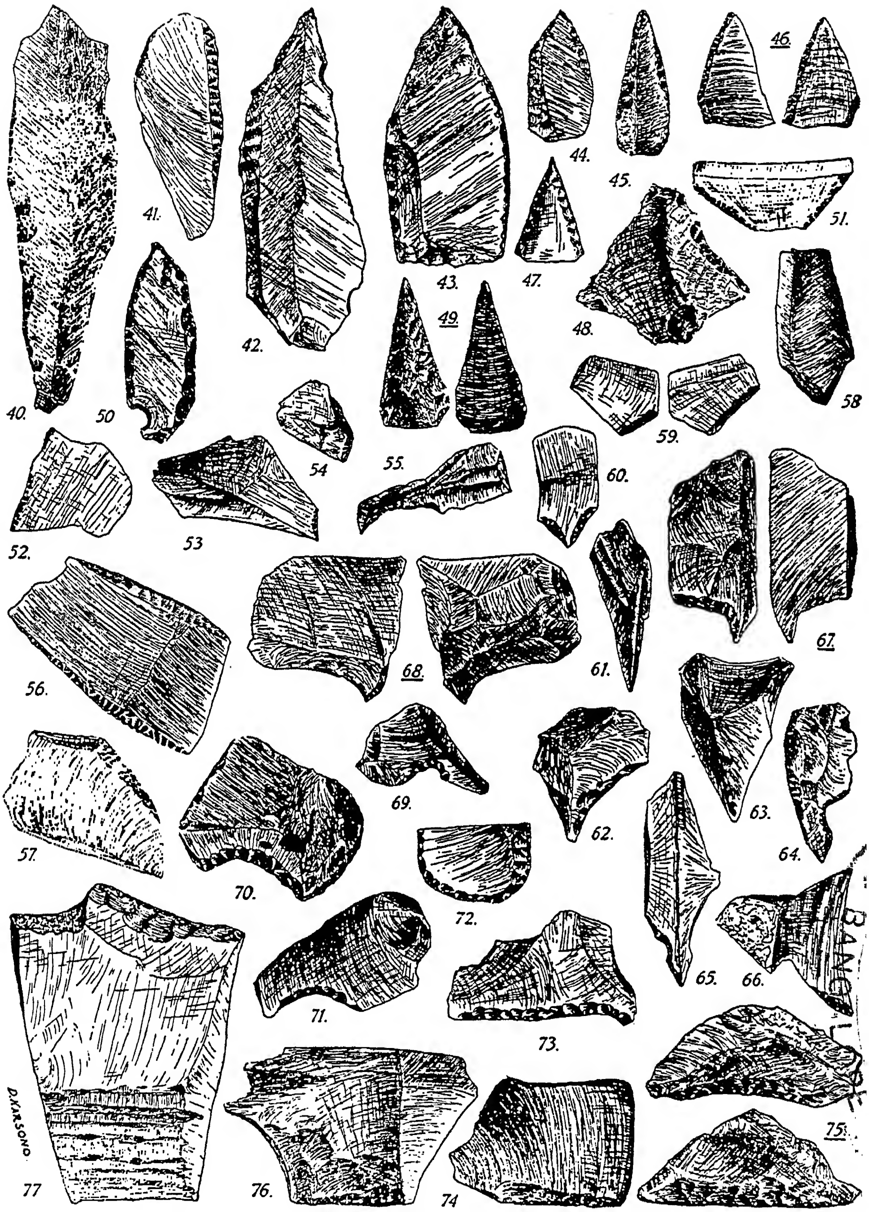


FIGURE 35. — POINTS, KNIVES, SCRAPERS, ETC. OF OBSIDIAN FROM THE SURROUNDINGS OF BANDOENG, WEST JAVA. (*From* VON KOENIGSWALD, 1935*b*.)

and, owing to his death, probably never will be published. So far, only a few very superficial observations and a few photographs have been made available. We cannot even say with certainty, whether the mesolithic and neolithic elements on that site are really chronologically distinct, as VAN STEIN CALLENFELS thought, or whether they do not represent a single culture of mixed character.

Neolithic finds have also been made in several caves. They consist mostly of a few objects lost by parties of hunters or warriors, who had used the caves as temporary shelters. Such, for instance, is the case in the uppermost layer of the Goewa Lawa near Sampoeng (15). Naturally, such stray objects contribute very little to our knowledge of neolithic culture. In other instances the neolithic objects were obviously owned by the mesolithic cave dwellers, who had acquired them from their more civilized neolithic neighbors. This applies to the neolithic arrow-heads and potsherds found at Toalian sites in Southwest Celebes. Some of these Toalian arrow-heads had probably been obtained by barter, while others were certainly fashioned by the cave-dwellers themselves in imitation of

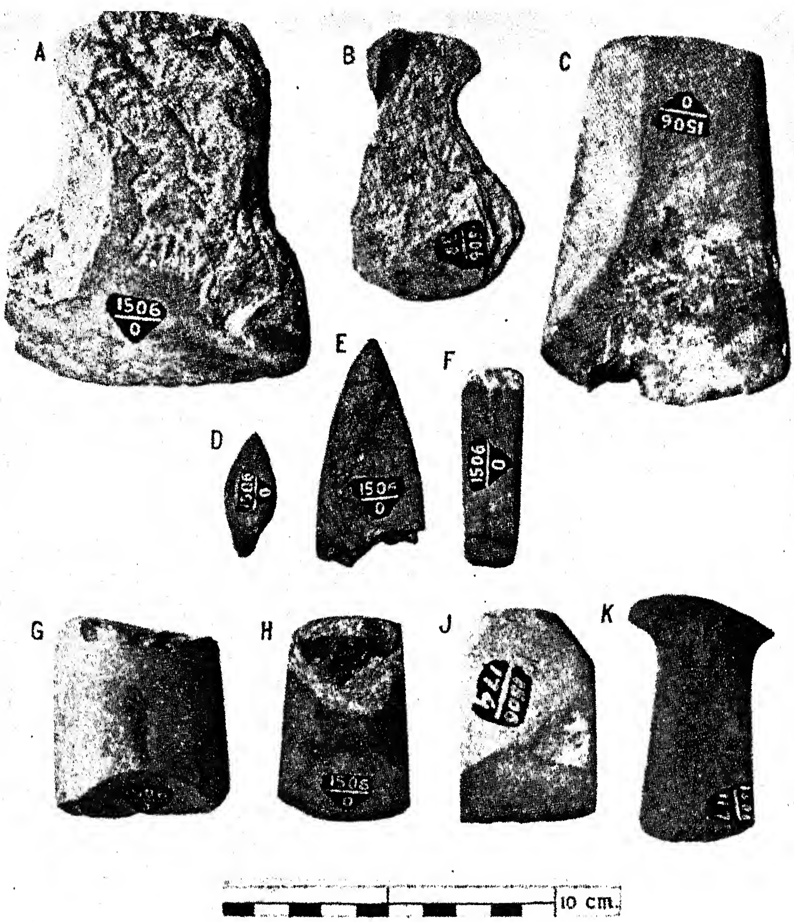


FIGURE 36. — STONE TOOLS AND WEAPONS FROM GALOEMPANG, WEST CENTRAL CELEBES. A: Tanged adze. B: Violin-shaped tool. D and E: arrow-heads. — Museum of the Koninklijk Bataviaasch Genootschap van Kunsten en Wetenschappen. (*From* VAN DER HOOP, 1941*b*.)

neolithic models. As far as the stone arrow-heads from the Goewa Lawa and from the caves at Bodjonegoro are concerned, there can be no doubt that they are the products of a full neolithic culture, even though in the Goewa Lawa the lowest stratum, in which alone they occur, is followed by a stratum containing a bone culture of predominantly mesolithic character (FIG. 29) (46).

Neolithic workshops have been found in one place in Sumatra and in great numbers in Java, especially around Buitenzorg and Poerwakarta in West Java, in the hills of South Preanger in West Java, in the southern part of Soerakarta, Central Java, and around Patjitan and Poenoeng, near the South coast in the southwestern part of East Java. Only the latter, which were discovered by VAN STEIN CALLENFELS in 1927, have been explored to a limited extent. They are very numerous, comprising approximately a hundred sites. Some of these contain exclusively stone arrow-heads of a type closely related to that of the Goewa Lawa and of the Bodjonegoro caves, while on others only unfinished adzes and chisels of the quadrangular type occur in enormous quantities. VAN STEIN CALLENFELS found indications that the arrow-heads belong to an earlier period than the adzes (47). Similar workshops with stone arrow-heads and unfinished adzes have been located near Batoewarno and Wonogiri in the Gouvernement Soerakarta, Central Java, while a workshop at Bagogoh in the Residency Buitenzorg, West Java, contained only unfinished adzes, but no arrow-heads (48).

The occurrence of neolithic stone arrow-heads in eastern and central Java, as well as at Toalian sites in Southwest Celebes, is rather puzzling, as such arrow-heads are unknown in the whole of Further India, the Malay Peninsula, Sumatra and West Java. As similar arrow-heads are frequent in the Neolithic of Japan, VAN STEIN CALLENFELS and the author assumed that they were introduced in Indonesia by a migration or cultural wave which reached Indonesia by way of the Philippines (49).

So far, our knowledge of the full Neolithic of the Archipelago is limited almost exclusively to stone axes, adzes and chisels, practically all of them stray and accidental finds. Thousands of them can be seen in the museums of Batavia, Leyden, Amsterdam, Rotterdam, Berlin and


FIGURE 37. — POTSHERDS WITH INCISED GEOMETRIC DESIGNS, GALOEMPANG, WEST CENTRAL CELEBES. — Museum of the Kon. Bataviaasch Genootschap van Kunsten en Wetenschappen (*From* VAN DER HOOP, 1941*b*.)

various other places (50). The variations in type indicate that they belong to several cultures of different origin or dating from different periods. Yet, as a result of the lack of systematic excavations, we have no means of establishing a chronological system based on stratigraphical evidence. Nor do the finds give more than a few rather vague indications about the culture of the neolithic settlers.

From the great number of neolithic workshops found in Java and from the enormous quantities of unfinished adzes and chisels which they contain, we may conclude that the manufacturing of stone tools was carried on on a large scale at places where suitable material was available and that a brisk trade in such tools must have existed all over Java. It seems that in Central Java adzes and chisels only half finished, roughly fashioned by chipping, were exported from the industrial centers, later to be polished by the people themselves who purchased them and used them, while in West Java the polishing seems to have been done at the workshops (51). There are indications that besides chipping, the other method of producing adzes and chisels, namely, by sawing the stone, which was widely used in the related neolithic cultures of continental Southeast Asia, was known in Java too (52).

From the huge number of finished and half finished stone tools occurring in Java, we may infer that that island must have had a relatively dense population. Moreover, the beautiful forms and the technical perfection of many of the adzes and gouges from Java and South Sumatra, often made from semi-precious stones, indicate that the peoples of these regions must have attained a comparatively high level of civilization during the later part of the Neolithic Period (FIGS. 38–40). Many of the best pieces were probably intended for ceremonial purposes.

This is practically all we can say with regard to the neolithic culture of Indonesia on the basis of direct evidence. In West and Central Java, numerous arm-rings of agate and chalcedony have been found, made either by the grinding method or by boring with the help of a bamboo. They are usually ascribed to the Neolithic (53). It is probable that this assumption is correct in

some cases, but so far we have no proof, and they might also date from a later period. A stone bark-cloth beater from Borneo, of a type frequent in the Philippines, and another one of the type still in use in Celebes, are probably of neolithic age, but here again there is no certainty (54).

Although pottery was already used during the end phases of the mesolithic hand-ax cultures of Sumatra and Borneo, we know practically nothing about the pottery of the full Neolithic. Various vessels and potsherds from Java and Sumatra have been tentatively ascribed to the Neolithic (55). In some cases this may be correct; in others it seems much more probable that we have to deal with pottery of the Bronze Age or an even later period. A large cemetery with urn burials on the island Soemba has been said to date from the Neolithic (56). However, I have strong doubts as to the correctness of this assumption. The fact that a stone adze was found in proximity to the urns proves nothing, as stone adzes were used also during the Bronze Age, and possibly even later.

At Galoempang in West Central Celebes (see above p. 134) VAN STEIN CALLENFELS found two kinds of potsherds: some of rough ware, either plain or decorated with textile impressions, and others decorated with incised patterns of hatched triangles, zigzag lines, wavy lines, spirals, meander-like designs and stylized human figures. He thought that the rough sherds belonged to the local mesolithic culture, and those with incised designs to the neolithic culture with quadrangular adzes and polished stone arrow-heads which he discovered on that site (57). The incised ornaments are obviously related to and derived from Chinese or Indo-Chinese Bronze Age designs (FIG. 37). Their closest affinity is with the decoration of a certain kind of pottery from the neolithic and Bronze Age site of Samrong-sen in Cambodia (58). Therefore, a date prior to the middle of the 2nd millennium B.C. seems out of question and a date in the second half of the 1st millennium B.C. the most probable one. If the sherds are really contemporaneous with the stone adzes and stone arrow-heads, they might eventually furnish a clue to the chronology of the Neolithic of Celebes. However, there is as yet no certainty whatever with regard to this. VAN DER HOOP, while pointing out that their ornaments are of Bronze Age rather than of neolithic character, prefers to term them provisionally simply as pre-Islamic (59).

Since stratigraphical evidence is totally lacking, the only method of trying to date the neolithic cultures of Indonesia seems to be the indirect one, based on the geographical distribution of the various types of stone axes and adzes and on their comparison with neolithic tools from continental Asia. I had indicated in 1923 the possibility of such a method and the facts on which it would have to be based (60). In 1926, VAN STEIN CALLENFELS in Java and I, myself, in Europe proceeded to apply it independently. Our arguments were based: (*a*) on the fact that, apart from Celebes, no tanged adzes, such as are characteristic of Burma, Siam and French Indo-China, were known from Indonesia and from the southern part of the Malay Peninsula; (*b*) on Father W. SCHMIDT's thesis, according to which the Mon-Khmer languages of Further India and the Munda languages of India both belong to one large linguistic group which he termed that of the Austro-Asiatic languages, while in turn, this group, together with that of the Austronesian (Malaio-Polynesian) languages, forms the Austric family of languages. As the distribution of the tanged adze in continental Southeast Asia coincides roughly with that of the Austro-Asiatic languages, it had already been assumed by various writers that it belonged to the neolithic culture of the peoples of this group.

Since the tanged adze is unknown in Indonesia (with the exception of Celebes), both VAN STEIN CALLENFELS and I argued that the separation between Austronesians and Austro-Asiatics, and consequently the emigration of the Austronesians from Further India, must have taken place prior to the development of the tanged adze. The latter could, to a certain extent, be dated, as it occurs, with other adze types of Southeast Asiatic origin, in the region of the Munda languages of India. Therefore, it seemed probable that it had been introduced in India by the same people who had introduced the allegedly Austro-Asiatic Munda languages. Since we assumed that this Austro-Asiatic migration from Southeast Asia to India must have antedated the immigration of the Aryans in India, and as it was obvious that the development of the tanged adze in Southeast Asia must have preceded the westward migration of the Austro-Asiatics, both VAN STEIN CALLENFELS and the author came to the same conclusion, *i.e.*, that the migration of the Austronesians to Indonesia and the introduction of the full Neolithic in the Archipelago could not have taken place later than around 2000 B.C. (61).

In recent years the correctness of Father SCHMIDT's thesis has been questioned (62). However, even if no relations should exist between the Mon-Khmer languages and the Austronesian languages on the one hand, and between the former and the Munda languages on the other, this would hardly affect VAN STEIN CALLENFELS' and my own conclusions. The connections between the recent, as well as the neolithic, cultures of Indonesia and Further India are so close that the fact that the tanged adze is not found in the larger part of Indonesia would still indicate that the main neolithic migration to Indonesia took place before the neolithic tanged adze had been fully developed on the mainland of Further India.

On the other hand, even if the Munda languages should not be basically related to the Mon-Khmer languages, there can be little doubt that at least some of the eastern Munda languages have been influenced by the latter. It is precisely in the region where these eastern Munda languages occur, that even today relatively strong traces of a Mongoloid racial strain are to be found. In the first century A.D. the Munda tribes of Orissa were called Kirāta by their Aryan speaking neighbors, that is with the Sanskrit term used to designate the Mongoloid mountain tribes of the Himalayas, Assam and Further India (63). We may infer from this that at that time the Mongoloid element among them must have been considerably stronger than today. Again, it is only in Orissa, Chutya Nagpur, and the northeastern Dekkan, as far south as the Godavari River and as far West as the region of Allahabad, that tanged adzes and other neolithic adze types peculiar to Southeast Asia have been found (64).

It is obviously highly probable that this neolithic culture of Southeast Asiatic origin, the Mongoloid racial elements and the traces of Mon-Khmer influence in the Munda languages, be

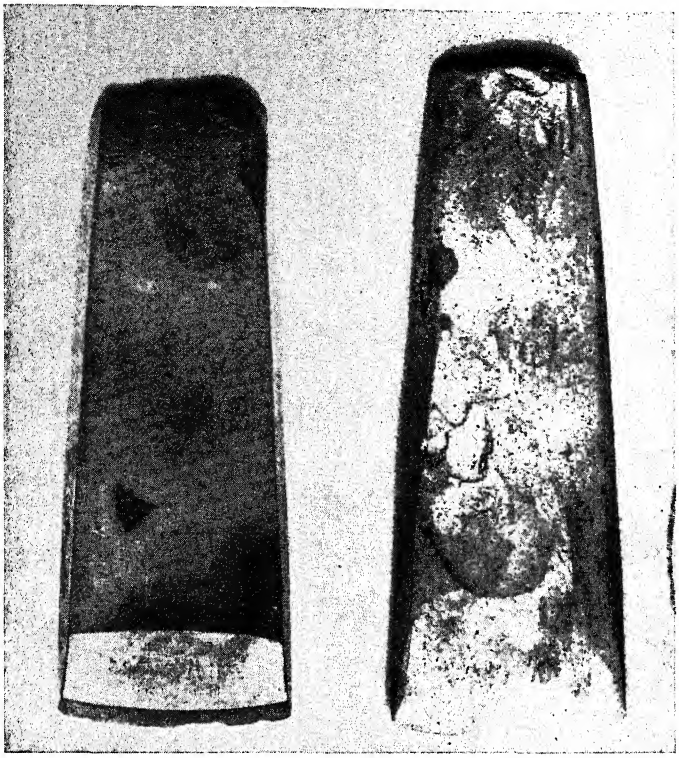

FIGURE 38. — ADZES OF JASPER (*left*) AND AGATE (*right*), WEST JAVA. (*By courtesy of* the Ethnographical Museum, Leyden.)

they ever so slight, were introduced into India at the same time and by the same migration of Mongoloid peoples from Assam or Burma. Therefore, I still think that the presence of tanged adzes in Orissa and neighboring regions provides a terminus ante quem for the Austronesian migration to the Archipelago. As matters stand, this migration may with great probability be dated between 2500 and 1500 B.C.

VAN STEIN CALLENFELS thought that he could go further in building up a relative chronology of the Neolithic of Indonesia. He tried to distinguish four periods, characterized by the types of axes and adzes (65). This method of basing a chronological system on purely typological considerations was, however, criticized and rejected both by the author and by VAN DER HOOP (66).

A problem of special interest and importance with regard to the Neolithic of Indonesia was of course the question which culture was to be attributed to the Austronesian (Malayo-Polynesian) peoples, and the determination of the latters' last common home-land before they spread over the islands. An attempt in this direction had already been made on a purely philological basis by H. KERN (67). Now, archaeology, too, came into its own.

VAN STEIN CALLENFELS was already on the right track, when he tried to identify the culture of his fourth "period" as that of the peoples who brought the Indonesian languages into the Archipelago (68). A few years later I was able to establish definitely that, what I called the "Quadrangular Adze Culture," had been the culture of the Austronesian peoples when they invaded Indonesia. This culture is characterized by adzes with quadrangular cross-section and, as far as western Indonesia is concerned, also by pick-adzes with a longitudinal ridge on the upper side and with pentangular or triangular cross-section (FIGS. 36, 38–40). At the same time, it appeared


FIGURE 39. — ADZE OF AGATE, WEST JAVA. (*By courtesy of* the Ethnographical Museum, Leyden.)

that the last common home-land of the Austronesian peoples before their dispersal must have been the Malay Peninsula. However, this "Austronesian" Quadrangular Adze culture, if we may so call it, could be traced even further back, and it became clear that it had come from China by way of the central regions of Further India. The development of the highly specialized pick-adzes of western Indonesia from a simple adze type with quadrangular cross-section and semi-circular edge, found in French Laos, through an intermediate type frequent in the Malay Peninsula, is particularly striking, and indicates clearly the direction and way of the ancient migration (69).

While the results of my archaeological studies confirmed in general those obtained by H. KERN on a purely philological basis, they compelled us to revise KERN's theory in two respects. KERN had come to the conclusion that the last common home-land of the Austronesian peoples before their dispersal had been a long-stretched, tropical coastal region. By reason of the presence of a strong Indonesian element in the languages of the Cham and neighboring tribes in French Indo-China, he believed that this Austronesian land of origin was most probably located on the coast of Annam (70). This view is not borne out by the archaeological facts, which point definitely to the Malay Peninsula. However, the coastal regions of that Peninsula bear out KERN's main thesis equally well, as does the coast of Annam. Further, KERN had argued that the original Austronesians had known iron even before their dispersal. This was the weakest point in his thesis, since the facts he adduced admit also of other interpretations. It is in complete contradiction to

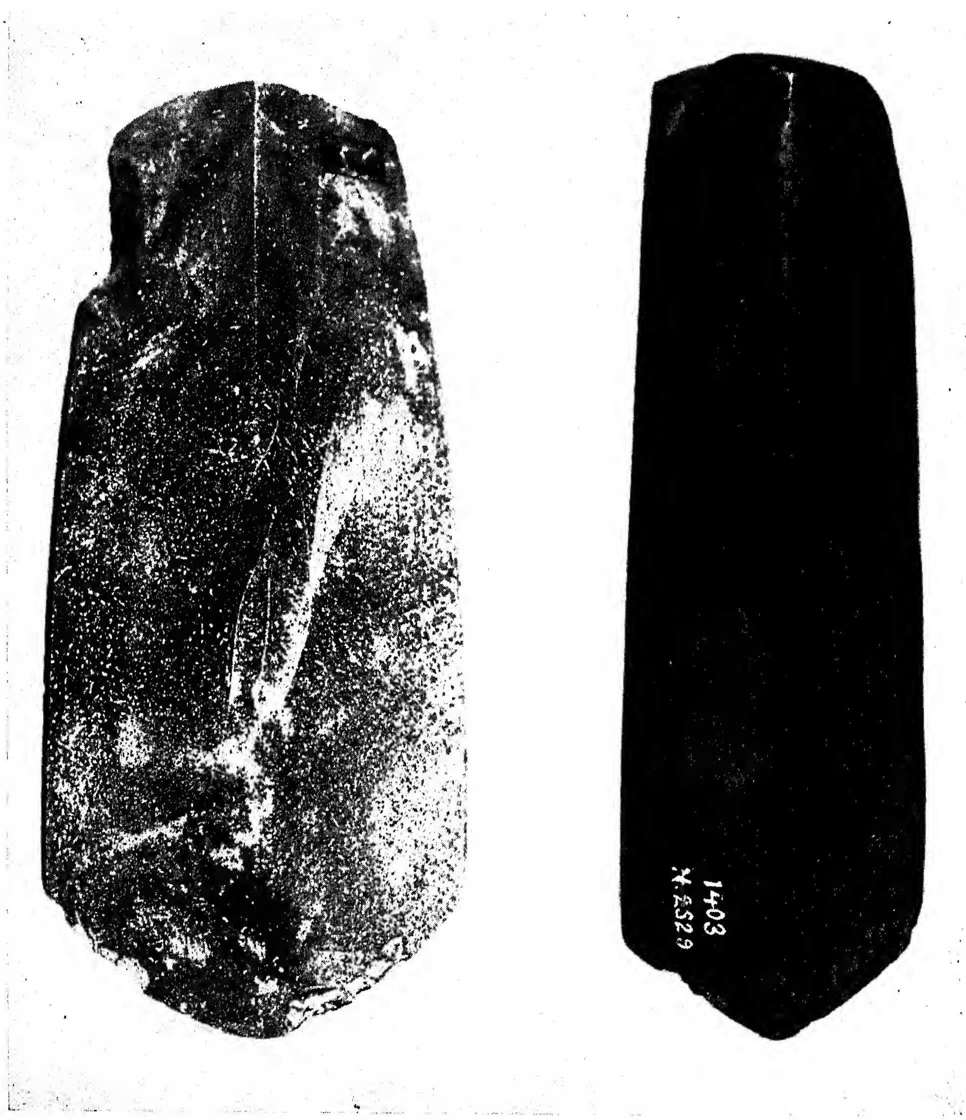

FIGURE 40. — PICK-ADZES OF SILEX (*left*) AND CHALCEDONY (*right*), WEST JAVA. (*By courtesy of* the Ethnographical Museum, Leyden.)

the archaeological evidence and must be dropped.

On the basis of finds made at various sites with quadrangular adzes in continental Southeast Asia, I tried to ascribe certain types of tools, weapons, ornaments and ceramic decorative designs to what I thought was the original Austronesian culture (71). However, these premature attempts did not sufficiently take into account the differences between the various branches of the Quadrangular Adze cultures of eastern Asia. The conclusions arrived at must be considered in part as uncertain and in part as definitely erroneous.

Better founded were the attempts to trace certain cultural traits, still prevalent among the peoples of Indonesia, back to the Quadrangular Adze culture and to show that they had already formed part of the original culture of the Austronesians. This refers to the planting of rice and millet, the special form of reaping knife used for harvesting rice, the brewing of beer from rice or millet, the raising of pigs, the raising of cattle or buffaloes for sacrificial purposes, a certain kind of technique for producing pottery, the manufacture of bark-cloth, the rectangular house standing on piles, the custom of head-hunting, the custom of erecting megalithic monuments as memorials of sacrificial feasts or as memorials to the dead, and a special style of art (72).

Even more significant were the results concerning the origin of the outrigger, that device which enabled the Austronesian peoples to spread not only over the whole of Indonesia, but as far as Madagascar in the West and Easter Island in the East. Boats with a primitive kind of outriggers made of bamboo are still in use on many rivers of Burma and French Indo-China. The most primitive forms are found on the Shweli in the Northern Shan States and on the middle Mekhong and its tributaries in French Laos, thus precisely in that region where, as archaeological evidence indicates, the ancestors of the Austronesians had lived before they migrated southward to the Malay Peninsula. From this I concluded that the river boat with primitive bamboo outriggers had been in use among the ancestors of the Austronesians when they still lived in the interior of the mainland and that when, in the course of their southward movement, they reached the coast, they developed it till it became the efficient craft which carried them to the farthest islands of Indonesia and over the Indian and Pacific Oceans (73). Recently, JAMES HORNELL came to similar conclusions, *i.e.* that the outrigger was derived from the primitive bamboo outriggers of river boats in the interior of Further India (74).

On the basis of potsherds with imprints of textiles which had been found in Java, VAN DER HOOP concluded that the neolithic Indonesians were familiar with the art of weaving (75). However, there is as yet no proof that the sherds in question date really from the neolithic, and not from a later period, and I consider it still probable that the original Austronesians, at the time of their immigration in the Archipelago, used solely bark-cloth.

Although the Quadrangular Adze culture was by far the most important among the full neolithic cultures of Indonesia, it was not the only one. The presence of another culture is indicated by axes or adzes of oval or lentoid cross-section and with more or less pointed or rounded necks. On the mainland of Asia, such axes are characteristic of the Neolithic of India. They are also found in Burma and China, where they probably represent an early phase of the full Neolithic, preceding the introduction of the various branches of the Quadrangular Adze cultures. The same is the case in Japan, Formosa and the Philippines. In practically the whole of New Guinea and Melanesia axes of this kind are or at least were recently still in use. In Indonesia they have been found in Borneo (FIG. 41), North Celebes, in the

FIGURE 41. — STONE AX, BORNEO. (*By courtesy of* the Ethnographical Museum, Leyden.)

Moluccas, in Leti and Tanimbar, further in a limited area on the East Coast of Sumatra.

By reason of the similarity of these prehistoric axes from Indonesia with the recent ones from New Guinea and Melanesia, VAN STEIN CALLENFELS and VAN DER HOOP have designated the respective neolithic culture of Indonesia as "Papua-Neolithicum." This is a rather unfortunate term, as we have no proof whatever, that the culture in question was actually introduced by Papuans. The term "Round-Ax Culture," which I proposed, seems less controversial. Since traces of this culture are absent from Java and the larger part of Sumatra, and also extremely rare in the Malay Peninsula, it seems probable that it reached Borneo and eastern Indonesia from China or Japan by way of Formosa and the Philippines. Whether the presence of "round axes" on the East Coast of Sumatra is due to an ancient migration from Borneo, or whether they represent traces of a separate branch of this cultural group which may have drifted southward from Burma, cannot yet be determined (76).

Another neolithic group, the existence of which VAN STEIN CALLENFELS and the author were able to establish, is so far known only from North and West Central Celebes and from Northeast Borneo, although it is probable that future research may reveal a wider distribution. It is characterized by tanged or shouldered adzes (FIG. 36A) and by quadrangular adzes. In some of the latter,

the back part of the upper side has been removed, thereby making the butt-end thinner and producing on the upper side a step which facilitated the hafting (FIG. 42). This Tanged and Stepped Adze Culture is really a highly specialized branch of the Quadrangular Adze Culture group which had assimilated elements of an earlier, still half mesolithic culture. It is closely related to the Late Neolithic of the South China coastal regions around Hongkong and was obviously introduced

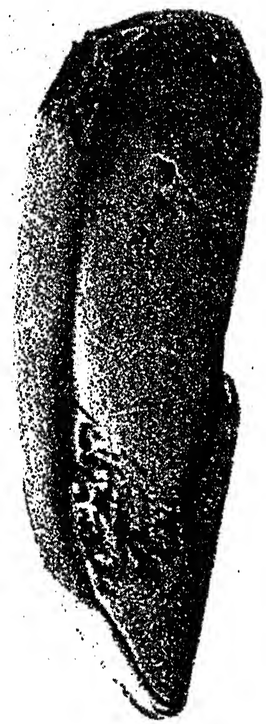

FIGURE 42. — STEPPED STONE ADZE, MINAHASSA, NORTH CELEBES. — Ethnographical Museum, Rotterdam. (*From* MEYER *and* RICHTER, 1902–03*b*.)

in Indonesia by way of the Philippines, where it is strongly represented. On the other hand, the tanged and stepped adzes of East Polynesia are very similar to those of South China, the Philippines, Borneo and Celebes, thereby indicating that it is in these regions that we have to look for the parent culture, or rather, for one of the parent cultures of that of eastern Polynesia (77).

From the above, it will be clear that in spite of the lack of excavations, some progress in our knowledge of the Neolithic of Indonesia had been made during the fifteen years between 1926, the year of VAN STEIN CALLENFELS' and the author's first systematic studies on the subject, and the beginning of the war in the Far East. On the basis of the geographical distribution of various stone tool types and of their comparison with the stone tools of other Asiatic and of Oceanian regions, it has proved possible to discern several culture groups of the full Neolithic, to determine the regions from where they had entered Indonesia, to obtain a limited idea of their character and at least some indications about their chronology, and to establish a link between one of these neolithic cultures and the most important ethnic and linguistic group of Indonesia. We should, however, be aware of the fact that so far only the merest outlines of the cultural history of Indonesia during the Neolithic Period have been recovered. An enormous task awaits here the prehistorians of the future, a task the more important, in view of the fact that the living cultures of Indonesia are to a very large extent still based on the foundations laid during the Neolithic. In order to accomplish this, by far more systematic and extensive excavations will have to be undertaken, than have been carried out in the past.

**Research on the "Bronze Age" of Indonesia:** — Even less is known about the end of the full Neolithic than about its beginnings. The question has so far, in fact, not been approached, even tentatively. We may assume that, as in Europe, the Near East, China and Indo-China, the production and use of stone tools continued through a large part, probably even through the whole of the "Bronze Age." In remote and isolated regions it may have lasted far into "historic" times. Thus, the inhabitants of the small island of Engano off the Southwest coast of Sumatra are said to have used stone adzes for boat building as late as 1770 A.D. (78). It is, therefore, possible, and even probable, that a considerable number of stone tools of neolithic character date from periods when the knowledge and use of metals had long since been introduced in the Archipelago.

Bronze celts from Celebes and the Moluccas had already been described, and some of them reproduced in excellent illustrations, by G. E. RUMPHIUS two hundred and fifty years ago (79). Almost two centuries went by till prehistoric bronze tools from Indonesia again received some attention. In 1882, WORSAAE observed that a culture using bronze had existed in the Malay Archipelago. He assumed correctly that it had been introduced from the mainland of Southeast Asia. Moreover, he reproduced RUMPHIUS' illustrations of bronze celts and one of the Javanese hallbard-like bronze weapons of the Leyden Museum (80). In 1902, MEYER and RICHTER summarized the little that was known about an Indonesian Bronze Age (81). My own summary, twenty years later, showed that with one exception only, that of the bronze drums, no progress had yet been made in our knowledge of the subject (82). Previously, there had been no indication whatever of their age. However, in 1918, H. PARMENTIER had proved that some of the motives to be found on the drums occurred also on bronze axes and bronze weapons from Indo-China (83). His work indicated the probability of at least the older bronze drums of Indo-China and Indonesia dating from the same period as the bronze celts and bronze weapons found in these areas.

The great advance in our knowledge of the Bronze Age of Indonesia came in 1929, when VICTOR GOLOUBEW published his article on the Bronze Age of Tonkin and North Annam and on the first excavations carried out at Dongson in North Annam (84). Not only were bronze drums actually found at Dongson together with bronze tools and weapons, but it became clear immedi-

ately that a close relationship existed between the Bronze Age cultures of Indonesia and of French Indo-China. A few years later, van der Hoop was able to show that some of the daggers, helmets and drums, represented on prehistoric stone sculptures of the Pasemah region in South Sumatra, correspond to those of the Bronze Age of French Indo-China (85).

By reason of all this I proposed to use the term of Dongson Culture for the whole of the Bronze Age culture of Further India and Indonesia, in the same sense as we speak of a Hallstatt Culture or a La Tène Culture, since Dongson was the first site where the respective culture had been recognized as a more or less complete unit (86). However, we should keep in mind that the term suggested is only a provisional one and that subsequent research may induce us to restrict its use to a considerable extent. Not only is it possible that there existed several distinct, though interrelated, Bronze Age cultures in Further India and Indonesia, but it becomes increasingly clear that during the period in question, Indonesia was affected not only by influences from Indo-China, but also by more direct contacts with China.

During recent decades the number of Bronze Age objects in the collections of the Batavia Museum has increased manifold. They come from the most diverse regions of the Archipelago, ranging from Sumatra in the West to New Guinea in the East. As a result, van Stein Callenfels, and above all van der Hoop, were able to give a much fuller view of the Indonesian Bronze Age than had been previously possible (87). Two points should, however, be kept in mind. First, apart from stone cist graves in Sumatra which yielded only a few scraps of bronze, but no complete bronze tools, no "Bronze Age" site has as yet been excavated in Indonesia. Second, we do not even know whether a pure Bronze Age, *i.e.* an age which knew the use of bronze, but not that of iron, ever existed in Indonesia. In the graves of Dongson in North Annam, a few iron weapons were found together with a by far larger number of tools and weapons of bronze and stone. But these iron weapons obviously date from the very end of the Dongson Culture period. An iron lance head was found in a stone cist grave in Sumatra (88). However, since it is possible that the use of such graves continued in Sumatra into the historic period, as was indeed the case in Java, this may not mean very much.

Figure 43. — Bronze socketed celts, West Java. (*By courtesy of* the Museum of the Kon. Bataviaasch Genootschap van Kunsten en Wetenschappen.)

In China iron was known, though little used, during the Late Chou period, *i.e.* since about the 7th century b.c. Therefore it is possible, although in my opinion not very probable, that the knowledge and use of bronze and iron may have been introduced in Indonesia at the same time, as van der Hoop assumes (89). It is only with this restriction that we may speak of a Bronze Age in Indonesia. It seems advisable to use, provisionally at least, the term Dongson Culture, leaving the question open, whether this culture knew iron from the very beginning or whether the use of iron was introduced only during its final phases.

As is the case in Further India, bronze socketed celts form by far the most numerous and most characteristic class of objects of the Indonesian Dongson Culture (fig. 43) (90). No flat bronze or copper celt has ever been found. The socketed celt indicates clearly the origin of the culture. It is not known in the Near East nor in

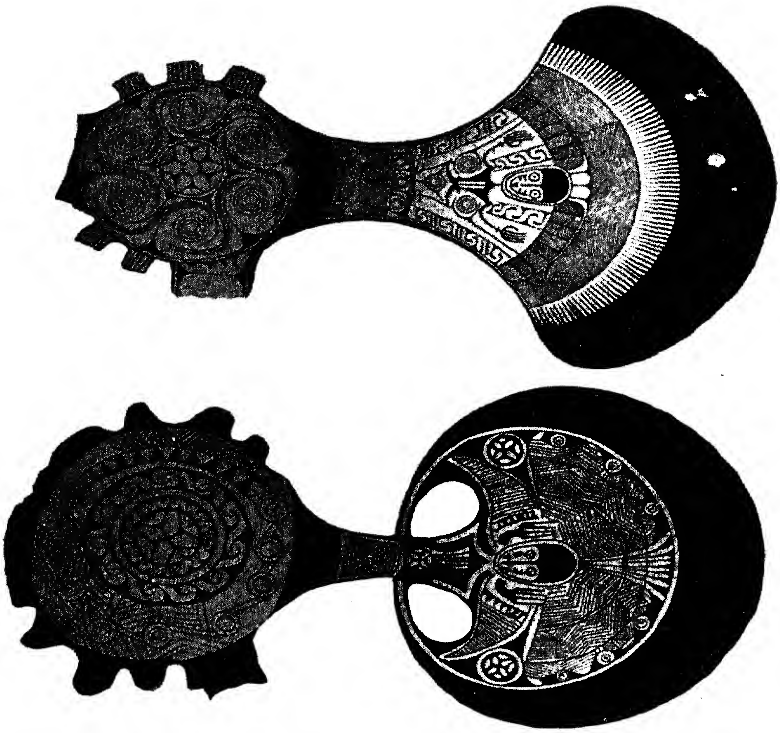

FIGURE 44. — BRONZE AXES, ROTI. — Museum of the Koninkl. Bataviaasch Genootschap van Kunsten en Wetenschappen. (*From* TEILLERS, 1910.)

FIGURE 45. — BRONZE DRUM, BONTOBANGOEN, ISLAND SALAJAR. (*From* VAN HOËVELL, 1904.)

India. We know that it originated in Europe and, by way of Siberia, spread to China, from where it eventually reached Further India and Indonesia. As I have pointed out, even ornaments characteristic of Siberian and East European socketed celts are found on celts from Java and Celebes (91). Other bronze objects comprise spades, halberd-like ceremonial weapons, the latter known only from Java, three beautifully decorated ceremonial axes from the island of Roti with blades as well as shafts of bronze (FIG. 44), fish hooks from Java and Celebes, a bronze imitation of a basket with spiral designs from Central Sumatra, an armor plate for the protection of the arm, also from Central Sumatra, jority is much younger and the production of mokos persisted at least far into the 19th century (96). If we except Alor, bronze drums or fragments of such are known from Sumatra, Java, Borneo, Bali, from the small island Sangean, Northeast of Soembawa, from Roti, Leti, Salajar (FIG. 45) and the Kai Islands.

Apart from purely ornamental patterns, some of the drums are adorned with naturalistic or stylized representations of houses, boats, elephants, tigers, deer, horses, peacocks, ducks and other birds, or with hunting scenes or scenes of festivals, groups of men wearing large feather head-dresses, etc. One drum, from Sangean, shows a man on horse-back and men wearing

FIGURE 46. — DETAIL OF BRONZE DRUM FROM THE ISLAND OF SANGEAN, NEAR SOEMBAWA. — Museum of the Kon. Bataviaasch Genootschap van Kunsten en Wetenschappen. (*From* VAN DER HOOP, 1941*b*.)

human and animal figures from Java and a bell from Bali (92). Numerous bronze arm and ankle rings have been ascribed to the Bronze Age (93). This is probably in part correct, but we have no means of dating them with certainty, and some of them may really belong to much later periods. Bronze spear and arrow heads have been found in Java, but, as VAN STEIN CALLENFELS has pointed out, their age is doubtful and it is possible that they date from the Hindu period (94).

The most interesting class of objects of the Dongson Culture are no doubt the bronze drums. As mentioned above (pp. 129 and 130), they had already received a considerable amount of attention during the last quarter of the 19th and the early years of this century. In recent years, the number of bronze drums in the collections of the Batavia Museum has multiplied. The catalogue published in 1941 lists twenty-eight specimens, of which detailed descriptions are given (95). This does not include the mokos or bronze drums of hour-glass shape from Alor, some of which seem to go back to the Bronze Age, although the ma-

Chinese or Tartar costumes (FIG. 46). Thus, the drums furnish valuable information about life and cultural forms during the Dongson Period. The religious significance of some of the scenes represented and their connection with the belief in life after death have been discussed by GOLOUBEW and by the author (97). Recently, F. M. SCHNITGER gave an interesting analysis of the designs on the drum of Salajar (98).

Some of the drums are very large, the largest, that at Pedjeng in Bali, being 6 feet high and having a diameter of 5½ feet (99). A miniature bronze drum from Java, only about three inches high, was no doubt intended to serve as a sepulchral gift and corresponds to similar small models of drums found at Dongson in North Annam (100).

Both the technique à cire perdue and the casting in moulds were known and practiced (101). While the miniature drum just mentioned was cast in the cire perdue process, the large drums were always cast in moulds. A stone mould for this purpose has been found in Bali (102). It

proves that at least some of the drums had been produced in place. However, the drums from Salajar and the Kai Islands, which show elephants, tigers and peacocks, none of which occur in eastern Indonesia, must have been imported either from the western part of the Archipelago or from the Asiatic mainland. One of the drums from Sangean, with figures of men in Chinese or Tartar dress, was probably imported from Tonkin or North Annam (FIG. 46).

A subject which had long puzzled ethnologists and archaeologists was that of ancient glass beads in Indonesia and New Guinea. In Timor and the surrounding islands a certain kind of yellow or orange colored glass beads is highly priced and thought to be of supernatural origin. Some are imported from South Sumatra, while others come from the island of Flores, where they are dug from the ground. As early as 1899 these muti salah, as they are called, were made the subject of a detailed and scholarly study by G. P. ROUFFAER (103). He came to the conclusion, understandable in his time, but, as subsequent research has shown, completely erroneous, that they had been imported by the Portuguese after 1550 A.D. In the northern part of Dutch New Guinea, antique glass beads are highly priced and used as currency. In the same region, there occur ancient glass arm rings which are considered very precious. VAN DER SANDE came to the conclusion that these glass objects had been imported from China in ancient times (104). There is a fair possibility that they date from the same period as the bronze celts which VAN DER SANDE found on Lake Sentani. VAN DER HOOP observes that in the Philippines glass rings similar to those from New Guinea belong to the Bronze Age culture (105). The same high esteem for antique glass beads as among the Timorese and Papuas is found among many of the inland tribes of Borneo (106).

The remarkable similarity of some antique beads from Borneo with European ones dating from Roman times, had already been pointed out by NIEUWENHUIS (107). As a result of an investigation on glass beads from Sarawak, BECK came to the conclusion that some of them may be of Greek or early Roman origin, dating perhaps from the 4th or 3rd century B.C. (108). Definite proof that at least a large number of the antique glass beads which used to be exported from South Sumatra to Borneo and Timor, date from the Dongson period, came when VAN DER HOOP excavated great quantities of such beads in two stone cists at Tegoerwangi in the Pasemah region of South Sumatra (109). The interesting problem of the introduction of glass in Indonesia in prehistoric times and the question whether beads of Mediterranean origin reached the Archipelago by way of Central Asia and China, or by overseas trade from Arabia or India, awaits further elucidation.

The Batavia Museum possesses large numbers of ancient beads, not only of glass, but also of carnelian or other kinds of stone (110). In most cases, their dates cannot be ascertained. VAN DER HOOP thinks that some of the stone beads may be of neolithic origin, but of this there is as yet no proof (111).

The chronology of the Dongson Culture has formed the subject of various studies. By reason of a few Chinese objects of Late Han type, and above all of Chinese coins of the first quarter of the first century A.D. which had been found at Dongson, GOLOUBEW considered the date of the cemetery there to be about 50 A.D. (112). However, as miniature replicas of bronze drums had been found in the graves of Dongson, I observed that the large drums must have been known and used for a considerable time, probably for centuries, before small models for purely funeral purposes were produced (113). Moreover, I pointed out that the decorative designs found on Dongson bronzes have very little in common with Chinese ones of the Han period, but are obviously related

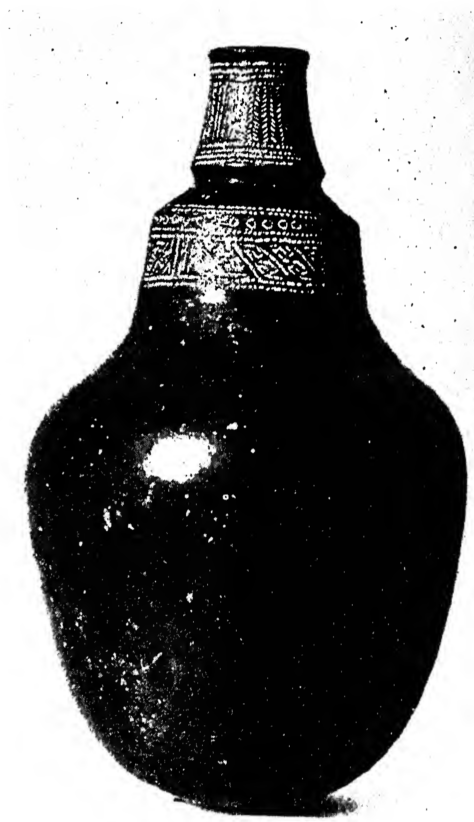

FIGURE 47. — EARTHENWARE FLASK FROM AN URN BURIAL NEAR LESOENGBATOE, SOUTHWEST SUMATRA. (*From* OV 1939.)

to the Late Chou style of China. From this I concluded that the Dongson Culture could not have originated later than about 300 B.C., and that an even earlier origin was probable (114). At the same time VAN STEIN CALLENFELS, basing his argument, as I had done, on the presence of funeral models of bronze drums in the Dongson graves, came to the conclusion that the finds from Dongson belong to the very end of the cultural period in question. He thought that the Dongson Culture had originated in Indo-China around 500 B.C. and from there had spread to Indonesia around 300 B.C. (115).

I had already drawn attention to the relations existing between the decorative designs of bronze objects from Dongson and from Indo-China and Indonesia in general, and those of the Hallstatt Culture of Europe and of the Early Iron Age of

Caucasia (116). A subsequent more systematic study yielded the following results.

The decorative designs found on bronzes of the Dongson Culture in Indo-China as well as in Indonesia, double spirals, circles linked by tangents (FIG. 44), meanderlike patterns, etc., are of western origin and closely related to, and indeed in many cases identical with, those of the Hallstatt Culture of Europe, the Thraco-Cimmerian Culture of the lower Danubian regions and South Russia, and the Early Iron Age of Caucasia. All these cultures were interrelated, and flourished side by side until the Cimmerians were driven from South Russia by the Scythians around 700 B.C. The numerous types of weapons, tools, ornaments and decorative designs of Hallstattian, Thraco-Cimmerian and Caucasian affiliation which are found in the Late Chou and Dongson Cultures of China and Indo-China must therefore have been brought to East Asia by western invaders who had left their homelands before the Scythian conquest of South Russia, *i.e.* at the latest during the 8th century B.C. It is highly probable that the barbarian tribes who in 771 B.C. destroyed the Western Chou Kingdom belonged to this same ethnic wave. In China, the decorative designs of western origin were immediately amalgamated with indigenous ones, thereby originating the Late Chou style of art. On the contrary, the decorative designs of the Dongson Culture perpetuate the western forms almost unchanged. From this we may infer that one stream of western invaders had branched off at the western confines of China and went directly southward to Yunnan and Indo-China, where their influence created the Dongson Culture, probably during the 8th and 7th centuries B.C. (117).

Of course, this gives us only a terminus post quem for the spread of the Dongson Culture to Indonesia. We still do not know when this culture actually reached the Archipelago. However, we can confidently say that this cannot have taken place earlier than about 600 B.C. and not later than some time during the second half of the first millennium B.C.

In his last paper on the subject, published the same year as my own results quoted above, VAN STEIN CALLENFELS commented on the various types of ornament occurring on bronze drums. He concluded by saying that he was inclined tentatively to set the date of the Indo-Chinese Bronze Age in which the oldest type of ornament occurs at 600 to 500 B.C., and the later phase with more degenerate ornament, which spread also to the South, *i.e.* to Indonesia, at about 400 to 300 B.C. (118). Thus, as had happened so often in the course of our work, my late friend and I had come independently and at the same time to almost identical conclusions.

I have repeatedly expressed the opinion that the Dongson Culture was introduced in Indonesia by the Yue peoples, the ancestors of the present day Annamites, who at that time lived in North Annam, Tonkin and the adjacent parts of coastal China. Moreover, I thought, and still think, that the introduction of this culture in the Archipelago was not due to large scale ethnic migrations, but rather to small groups of merchants and colonists who gradually became absorbed into the local population, much the same as the Hindu colonists of the subsequent period (119). VAN DER HOOP is of the opinion that the introduction of the Dongson Culture in the islands was due to a "second Indonesian immigration," the first one having taken place during the Neolithic (120). Both views are not necessarily contradictory, since the southern neighbors of the Yue in the coastlands of Annam were the Cham, a people with Indonesian, or at least half Indonesian, language. It is quite possible that both Yue and Cham took part in the colonial movement in question. In addition to this, it is possible that another wave of Bronze Age culture may have reached the Archipelago from Yunnan by way of Siam or Burma.

**Early Chinese Contacts:** — In 1934 I had pointed out stylistic similarities between some of the prehistoric stone sculptures of the Pasemah region in South Sumatra and those standing at the tomb of the Chinese General HUO K'IU-PING in Shensi province, erected in 117 B.C. This seemed to indicate more or less direct contacts with China, to be dated probably in the 2nd or 1st centuries B.C. (121). Since the article quoted above was published, Chinese objects of the Han period have actually been found in Indonesia.

A considerable number of Chinese sepulchral pottery vessels of the Han period were excavated in Sumatra, Java and Borneo, one of them, from Sumatra, bearing an inscription dating it 45 B.C. From these finds, DE FLINES inferred, no doubt correctly, that Chinese colonists or merchants must have lived in Indonesia as early as the Han period (122). The date of the Sumatra vessel agrees with the stylistic affiliations of Pasemah stone sculptures referred to in the preceding paragraph. Also there comes from Sumatra a bowl with engraved designs of persons in Chinese dress and of horses in Han style. It is supposed to have been made either locally or in Further India, in imitation of Chinese vessels (123).

A Chinese bronze dagger-ax (ko) is said to come from Sumatra and another one from Java (124). From Sumatra, too, come two bronze axes of typical Chinese form with quadrangular sockets (125). To this may be added one of the drums from Sangean. As mentioned above, it shows men wearing Chinese or Tartar dress. On one of its panels there is a representation of a man on horseback. In front of the horse stands a warrior, again dressed in the long Tartar coat, and armed with one of those long and thin iron swords which during the Late Chou and Han periods were used in China side by side with short bronze swords (FIG. 46) (126). The warrior wears a helmet with two projections on the top, reminiscent of the helmet of one of the stone sculptures of Pasemah (127).

Taking all this into account, one may come to the conclusion that direct Chinese influence in Indonesia goes back at least to the Early Han period, that is, at the very latest to the 1st century B.C. However, the ornamental designs of the Dayak tribes of Borneo and of the Ngada of Flores are so closely related to Chinese designs of the Late Chou period that one can hardly avoid the inference that Chinese contacts started at least as early as the beginning of the third century B.C., and possibly earlier. The subject has great historical significance, but has so far not been systematically investigated.

**Iron Age:** — As stated above, iron seems to have been already known and used during the period of the Dongson Culture, at least during its final phases, and possibly even from its very be-

ginnings. It is probable that its general use started only after the establishment of the first Hindu colonies in the Archipelago (first or second century A.D.?). However, it spread more rapidly than Hindu culture, and since many tribes in remote islands and in the interior of Borneo and Celebes remained outside organized Hindu or Mohammedan rule and some of them continued to live under "prehistoric" conditions as late as the beginning of this century, we may well speak of a prehistoric Iron Age. So far, very little is known about this full Iron Age.

VAN DER HOOP excavated a few stone cist graves in the Goenoeng Kidoel in the region of Wanasari, Central Java. They contained iron tools, potsherds, glass beads, bronze ornaments and fragments of textiles (128). VAN DER HOOP found no indication of the age of the graves, save that the large number of iron tools, the character of the glass beads and the composition of the bronze, which contained no lead and therefore is quite different from that of Dongson bronzes, show that they must be of later date than the stone cist graves of Pasemah. They may be tentatively ascribed to the first centuries of the 1st millennium A.D.

Iron objects, potsherds and glass beads were found also by VAN HEEKEREN and WILLEMS in some megalithic graves in the easternmost part of Java (129). A few sherds of Chinese glazed pottery of the 9th century indicated that at least one of these graves had still been in use at a time when Hindu culture was already firmly established a little further to the West (130).

**Urn Burials:** — The subject of cemeteries with urn burials, found in various parts of Celebes and on the island of Soemba, is still an archaeological puzzle. So far, nothing definite is known concerning their date and cultural significance. WILLEMS excavated one of these cemeteries in Central Celebes, but found no artifacts of any kind in or near the urns and no indication of the latter's age (131). KRUYT thought the custom of burying the dead in urns had been introduced by waves of conquerors who had already been Hinduized and who invaded Celebes from the South. He points out that, according to tradition, urn burial was used by the kings of the Bugis until their conversion to Islam (132). In spite of this, I doubt that KRUYT's interpretation is correct.

Two urn burials, forming probably part of a larger cemetery, were discovered at Lesoengbatoe in the highlands of Southwest Sumatra. The urns contained two earthenware flasks decorated with incised meanders and other designs of Bronze Age character (FIG. 47) (133). We may infer from this that the burials probably date from the Dongson period, although, in view of the survival of Dongson motives, a later date is not quite out of question.

As mentioned above, VAN DER HOOP, by reason of a stone adze found in the urn field of Melolo on Soemba, ascribed the latter to the Neolithic (134). However, the occasional use of stone tools may well have continued in the Lesser Sunda Islands far into the first millennium A.D. The shapes of the smaller vessels found in the urns would seem to preclude a culture of true neolithic character. One of the flasks is obviously closely related to those from Lesoengbatoe in Sumatra. This indicates a date not prior to the Dongson period.

Although nothing certain can so far be said, it would seem probable that the custom of urn burial was introduced from Indo-China during the Dongson period and that it continued in some localities well into the 2nd millennium A.D.

**Studies on Megaliths, Primitive Stone Sculptures and Rock Graves:** — Megalithic monuments are to be found in many parts of Indonesia. They comprise menhirs, single or in groups, dolmen-like structures, stone benches, stone-cist graves, stone jars, stone sarcophaguses, stone walls, terraces, cairns, stepped pyramids, stone stairs, stone bathing places, megalithic assembly places, and stone sculptures, ranging from simple "statues menhirs" with mere indication of the face, and sometimes the genitals, to more or less naturalistic figures. Some of them date from prehistoric times; others are known to have been erected in historic periods, while among many peoples of Indonesia "megalithic cultures" are still fully alive and megalithic monuments are being erected even today. The chief centers of living megalithic cultures are the islands of Nias, Flores and Soemba, but in a less vigorous form the use and erection of megaliths persists in many other regions of the Archipelago. Even in Java and Bali and among the Minangkabau Malays of Sumatra, megalithic monuments are still in use as local sanctuaries or for certain ceremonial purposes.

While many reports were devoted to recent megaliths and the customs and beliefs connected with their erection, archaeological interest in ancient megalithic monuments set in late and, till now, has been carried on in a rather sporadic way. The first detailed description of prehistoric megaliths, the megalithic graves of Bondowoso in the Residency Besoeki, East Java, was given by STEINMETZ in 1898 (135). A year later, KOHLBRUGGE described terraces with menhirs on the Argopoero Mountains of East Java. He thought that they were of Hindu character and the remains of a phallic sanctuary of Siva (136). This erroneous assumption was later corrected by STUTTERHEIM, who compared the Argopoero terraces with the ahus and maraes of Polynesia and came to the conclusion that they were of pre-Hindu or, as the time of their erection is not known, rather of non-Hindu origin (137). In the early part of this century, KRUYT, KILIAAN and GRUBAUER reported the existence of prehistoric "statues menhirs," stone vats and other megalithic remains in Central Celebes; prehistoric at least in the sense that their origin and the time of their erection are not known to the local population (138).

The first general explanation of the origin of megaliths in Indonesia was proposed by J. MACMILLAN BROWN, who thought that they represented traces of the migration of a "Caucasian" race which had come from the Mediterranean region by way of southern Asia. More comprehensive were PERRY's studies of the megaliths of Indonesia, their origin and meaning, published in 1918 and 1923 (139). PERRY assumed that the custom of erecting megalithic monuments was an element of what he called the "Archaic Civilization," said to have originated in ancient Egypt. He thought that it had been introduced in Indonesia, as well as in many other areas, by a series of migrations which had ultimately come from Egypt and were undertaken by people in quest of metals, especially of gold, and also of pearls, said to have been considered as magic "givers of life."

These ancient metal workers, who considered themselves as having descended from the sky-world ("Children of the Sun") and who imposed their rule on the various primitive tribes, brought with them a sun cult, the knowledge of agriculture and of metals, the art of producing polished stone tools, and many other elements of higher civilization.

Since Perry's conclusions were based on insufficient knowledge of the actual facts, and since the soundness of his methods was highly questionable, they met with almost universal rejection. However, although his main thesis is unacceptable and is, indeed, in complete contradiction to well established archaeological facts, his books contain many valuable and stimulating observations. It might prove a worthwhile task for a future critic, who is both patient and unbiased, to extricate these valuable sections from the maze of arbitrary and phantastic interpretations and unfounded assertions in which they are imbedded.

In 1928 I published the results of an investigation into the forms of monuments and "megalithic" beliefs and rituals found among peoples in Assam, West Burma and Indonesia who still practice the erection of stone monuments (140). I came to the conclusion that, with very few and unimportant exceptions, the megaliths are connected with special notions concerning life after death; that the majority are erected in the course of rites destined to protect the soul from the dangers believed to threaten it in the underworld or on its way there, and to assure eternal life either to the persons who erect the monuments as their own memorials while alive, or to those to whom they are erected after their death; that at the same time the megaliths are destined to serve as a link between the dead and the living and to enable the latter to participate in the wisdom of the dead; that they are thought to perpetuate the magic qualities of the persons who had erected them or to whom they had been erected, thereby furthering the fertility of men, livestock and crops and promoting the wealth of future generations. I compared the forms of monuments and the beliefs connected with them with similar ones in Oceania, Central Asia, India, ancient Palestine and Europe and found that they were everywhere essentially identical or, at the very least, closely related, thereby indicating a common origin, probably somewhere in the Mediterranean region. Although the wide distribution of the megalithic complex was a clear indication of its great antiquity, I left the question of the date of its introduction in Indonesia, and in Southeast Asia in general, open. Further research convinced me, however, that it must have been brought by the same ethnic wave which introduced the neolithic Quadrangular Adze Culture (141). If this proves correct, its first appearance in Indonesia would probably have to be dated between 2500 and 1500 B.C.

The existence of large stone sculptures on the Pasemah plateau of South Sumatra had been reported as early as 1850. During the second half of the 19th century they had been seen and described by several visitors to the region. In this century, L. C. Westenenk had published detailed descriptions and photographs (142). All the earlier authors referred to the images as works of the Hindu period. It was only the late Professor van Eerde who, while passing through Pasemah in 1929, expressed the opinion that they might be connected with the numerous menhirs and dolmens found in the same region. The following year F. D. K. Bosch, head of the Archaeological Service, visited Pasemah and again called attention to the megalithic remains he found there (143). It was at van Eerde's suggestion that van der Hoop was sent to Sumatra in 1931 with the express task to investigate the images and other megalithic remains of Pasemah. The book in which van der Hoop published the results of his research is one of the most important contributions to the prehistory of Indonesia. It threw light on a period until then practically unknown, revealed culture contacts of which we previously had hardly the faintest idea, and marks an important step forward in our knowledge of the megalithic cultures of Indonesia (144).

In the course of his survey of Pasemah and neighboring regions, van der Hoop found the following classes of monuments: (*a*) Upright stones (menhirs), single or in groups. (*b*) Dolmens. These had not been used as graves, but were obviously memorials similar to those which are still being erected in Nias and other islands of the Archipelago and among the hill tribes of Assam. (*c*) Stone troughs, which had probably served as receptacles for the skulls of the dead, as is still the case in Nias. (*d*) Stones with a flat upper surface in which one or more circular hollows of approximately 6 inches diameter and depth had been made. The local population calls them lesung batu, "stone rice-mortars." Van der Hoop thought that they had been used for husking some sort of grain (145). (*e*) Terrace graves. (*f*) Stone cist graves. (*g*) A few primitive stone images, obviously ancestor figures, similar in style to the wooden ancestor figures found among some of the more primitive tribes of the Archipelago and in New Guinea. (*h*) A considerable number of large stone images of a strongly dynamic, agitated style; the very images which Westenenk and other authors had previously referred to as remains of the Hindu period. They represent warriors with helmets and daggers, groups of two or three people, men riding on elephants or buffaloes (FIG. 48), an elephant with a warrior on each side, both warriors carrying bronze drums on their backs, a man fighting an elephant, two men fighting a serpent, two tigers pairing, the tigress clutching with her fore paws the head of a human figure, etc. (*i*) A flat stone with the relief of a human figure in the same style as the images.

Van der Hoop excavated two stone cist graves in which he found fragments of bronze ornaments, a gold nail and numerous glass beads (see above p. 146). On the inner wall of one of the graves were remnants of a painting in color, showing the upper half of a human figure and traces of an animal figure, probably a buffalo. This painting reveals the same style as the images. By reason of the bronze drums, helmets and daggers represented on the images, van der Hoop assumed the monuments to be of the same date as the finds from Dongson in North Annam.

During the years following van der Hoop's investigations, several hitherto unknown monuments were discovered in the Pasemah region, all in the typical dynamic Pasemah style. One of the most important ones is a stone with a relief representing two men, two buffaloes, a dog and a crocodile. The two men carry one of the well known bronze drums. A megalithic chamber

grave yielded two paintings, a man with a buffalo (FIG. 49), and a man with an elephant (?) (146).

SCHNITGER reported megalithic monuments from various parts of Sumatra. At Sintoeo in Minangkabau he found a stone terrace with several seats, at Aoer Doeri and other places in Central Sumatra stone pillars with curved capitals and carved ornaments which he rightly compared to similar monuments found on the Malay Peninsula. In Kerintji and upper Djambi he found large "cannon-shaped" pillar-like stones lying flat on the ground. Those in Djambi, which had previously been described by DE BONT, are decorated with meander-like designs, rows of concentric circles, probably correctly interpreted by SCHNITGER as representations of gongs, and in one case a primitive human figure (147). The age of these remains is not known, but they could hardly antedate the Dongson Period and probably are considerably later.

FIGURE 48. — STONE STATUE OF A MAN RIDING ON A BUFFALO, PEMATANG, PASEMAH, SOUTHWEST SUMATRA. (*From* VAN DER HOOP, 1932.)

In Java various groups of megalithic monuments and terraces were described by VAN DER HOOP, VAN TRICHT, L. ADAM and others (148). Some among them may go back to very early times, while others were erected during the late Hindu period. The terraced monument on the Jang Plateau in the Argopoero Mountains, previously described by KOHLBRUGGE, was revisited by DE JONG (149). The megalithic graves and monuments in the Districts of Bondowoso and Djember, Residency Besoeki, East Java, were investigated, and some of the graves excavated by DE HAAN, VAN HEEKEREN and WILLEMS. The graves consist either of stone sarcophaguses, some of them adorned with primitive sculptures, or are built of upright slabs and covered with huge monoliths. Their contents, as well as objects found in a contemporary megalithic emplacement, glass beads, stone bark-cloth beaters, pottery, ornaments of gold and copper and, in some cases, a few iron tools, prove that at least some of the graves and monuments date from the Iron Age period. As already stated, the discovery of sherds of glazed Chinese ware in one of the graves proves that it was still in use in the 9th century A.D., although it may, of course, have been built earlier (150). The custom of burying the dead in stone sarcophaguses persisted even later. Some of the latter bear inscriptions dating them as late as the 14th century (151). The Iron Age stone cist graves of Goenoeng Kidoel in Central Java have already been mentioned (see p. 148) (152).

It will be seen that all the stone cist graves and slab built graves of South Sumatra, Central and East Java contained glass beads and metal, bronze, gold, copper or iron. The same was the case in similar graves that have been investigated in the Malay Peninsula (153). From these facts we may infer that the use of such graves was introduced in Indonesia not earlier than the Dongson Period. On the other hand, the discovery of a stone cist grave near Cheribon in West Java which contained neither metal nor glass beads, but three stone adzes, seems to indicate that the ethnic or cultural wave in question must have reached Java during a relatively early phase of the metal ages, when stone tools were still largely used (154).

Several stone sarcophaguses have been found in Bali (155). Although we have no direct evidence of their age, save that one contained a fragment of copper or bronze, we may assume that they are more or less contemporary with those of East Java, thus dating from the 1st millennium A.D. or, possibly, even later.

The stone images and stone vats of Central Celebes, previously reported by KRUYT, KILIAAN and GRUBAUER, were described by KAUDERN and RAVEN (156). In 1932, KRUYT made them the subject of a study in which he came to the conclusion that they had been made by a people who had come from the North, probably with a Bronze Age culture (157). In the same year, MADELEINE COLANI drew attention to the similarity of the stone vats of Celebes to those of French Laos (158). In 1938, KRUYT as well as KAUDERN gave full and very valuable surveys of all the megalithic monuments of Central Celebes, menhirs, stone images, grooved stones, stone mortars, stone vats, etc. (159). However, KAUDERN's conclusion that this megalithic culture flourished in Celebes before the buffalo had been introduced is open to grave doubts. Nor can his dictum that "all attempts to fix definitely in time these megalithic finds . . . seem to be entirely useless in view of the very limited knowl-

edge we have regarding them," be admitted as valid. He seems to have overlooked Madeleine Colani's work on the stone vats of French Laos which definitely gives a clue about the age of such monuments (160). Those of Laos cannot be older than the Dongson Period, and, in view of the quantity of iron tools found in their vicinity, are probably later. They may date from the first centuries of our era.

Stone sarcophaguses resting on stone pillars decorated with primitive sculptures of human figures have been reported from the Apo Kajan region in Central Borneo. Their origin is unknown to the present population (161).

Archipelago, the area of the younger megalithic culture is much more restricted and, as I thought at that time, this culture had completely disappeared from present day life (162). Subsequent research has convinced me that this latter assumption was erroneous and that the younger megalithic complex still survives among the Batak of Sumatra and in Soemba and, to a certain extent, strongly mixed with elements of the older complex, on the island of Nias.

This distinction between an older and younger megalithic culture has since been adopted by van der Hoop, Vroklage and Willems (163). Future research will probably show that the migra-

Figure 49. — Painting on the inner wall of a stone chamber-grave, Tandjoeng Ara, Pasemah, Sumatra. (*From* de Bie, 1932.)

On the basis of van der Hoop's results in South Sumatra and of metal finds in the megalithic graves of the Malay Peninsula and of Java, I had to revise my chronology of megalithic cultures. I came to the conclusion that we had to distinguish at least two, and possibly more, megalithic waves which reached Indonesia at different times. The older one (in reality probably a series of ethnic and cultural waves) came in the neolithic period with the peoples who introduced the quadrangular Adze culture, thus probably between 2500 and 1500 B.C. It introduced the custom of erecting menhirs, single or in groups, dolmens (not used as graves), stone seats, stone terraces, stone pyramids, megalithic assembly places, various types of stone tombs, etc. The younger megalithic wave (again probably a series of migrations rather than a single one) came during the period of the Dongson Culture and the Early Iron Age and introduced the use of stone cist graves, dolmen-like slab graves, stone sarcophaguses and stone vats. While the older megalithic culture spread over wide regions of Indonesia and from there to Oceania, and survives even today in many parts of the Malay

tion which brought the use of stone vats for burial purposes to Celebes and also to the Batak of Sumatra, although more or less contemporaneous with that which introduced the use of stone cist graves, was nevertheless distinct, coming from another region and by different routes. In contradiction to Kruyt's theories, I consider it probable that stone vats and urn burials belong to the same culture. The stone sarcophaguses of Java and Bali may turn out to be due to later influences than the stone cist graves.

Van Stein Callenfels thought that the custom of burial in stone cist graves might have been introduced by the earliest wave of immigration from South India. The same view was expressed by Stutterheim (164). On the other hand, I had pointed out strong stylistic similarities between the Pasemah images and reliefs and Chinese sculptures of the early Han period. Since the paintings on the inside of some of the stone cist and chamber graves of Pasemah show the same style as the images and reliefs, there can be no doubt that the graves belong to the same culture and date from the same period as the latter. I therefore suggested that the use of stone cist

graves and chamber graves might have come from China, where similar grave forms occur during the Han period (165). Willems, too, admits the possibility that the megalithic graves of East Java might be of Chinese origin. He even refers to local traditions, previously reported by Steinmetz, according to which the graves are indeed said to be those of ancient Chinese (166).

Primitive stone images, in most cases no doubt ancestor figures, are found in many islands of the Archipelago. Except where they are of quite recent origin, their age can rarely be determined. Some of them may be remnants of the neolithic Quadrangular Adze Culture. Others show some affinity with the Pasemah sculptures and may date from the early metal ages. Others still reveal stylistic influences derived from Hindu-Buddhist art, while a great number have no doubt been made during the very last centuries, even though their origin may have been forgotten by the local population. In Nias, in Soemba, among the Batak of Sumatra and in various other islands and areas, the art of primitive stone sculpture is still more or less alive. It would lead too far to go into details. Therefore, I shall confine myself to listing a few of the more recent books and articles dealing with the subject, leaving aside such regions as Nias, Soemba or the Minahassa, where we so far have no means of distinguishing between ancient and recent monuments.

The stone sculptures of the Batak country in Sumatra were studied by Schnitger and above all by Voorhoeve and Tichelman (167). The primitive stone images of Java have long been known and were usually referred to as "Polynesian images," a highly inappropriate term, which took no account of the distinction between Indonesians and Polynesians (168). They have recently been studied by van Heekeren, Willems, Röder, Tichelman and the author (169). Ancient stone sculptures from the western part of Flores were discussed by Vroklage (170).

Apart from Celebes, where they are still made and used by the Sa'dan Toradja, rock-cut chamber graves are known from Java, Sumatra and Borneo. Those of Sumatra have been investigated by van Stein Callenfels, Voorhoeve and Tichelman (171). Some contain reliefs or wall paintings. Their age has not yet been determined. A few may date from the Hindu period, while others may be older. A relief of a bird near the entrance of one of those artificial caves in the Batak country corresponds stylistically to a motif frequently found on bronze drums of the Dongson culture and on Chinese tiles of the Han period (172). Three rock-cut chamber graves with primitive sculptures of human faces over their entrances have been discovered in the Apo Kajan region of Central Borneo (173).

Although nothing definite can so far be said, it seems probable that the use of rock-cut graves originated or was introduced during the Dongson period.

**Survival of Prehistoric Art Styles:** — In 1929, Victor Goloubew compared the boats represented on bronze drums of the Dongson Culture with Dayak paintings representing spirit boats and proved their close connection. Moreover, he observed the similarity of the double spiral designs on the drums and other bronzes to those of the living arts of the Dayak and Batak (174). This suggested a new way of approach to the problems of the prehistory and ethnology of Indonesia. An investigation which I undertook on the basis of this incentive, led to the distinction of two main styles of living primitive art in Indonesia, both of which could be linked to prehistoric cultures. The first of these styles is mainly sculptural and monumental and in its original aspect seems to have almost completely lacked purely ornamental design. The works it produced, sometimes in stone, more frequently in wood, consist in ancestor figures or in reliefs, either commemorating achievements in war or the chase or the accomplishment of sacrificial rites (human heads, heads or horns of bulls, etc.), or in magic symbols of fertility and wealth. This monumental style could be proved to be that of the older megalithic culture. Consequently, its origins must reach back into the neolithic period. It survives in its pure form among the mountain tribes of Assam, West Burma and North Luzon. In Indonesia it occurs in a relatively pure form on the island of Nias, and its traces are spread far over the Archipelago. The second style is mainly ornamental and delights in beautiful curvilinear designs, double spirals, etc. Moreover, it produced and still produces paintings representing mythological scenes or scenes of daily life. The close similarity of its ornaments and paintings to the ornaments and scenes on the ancient bronze drums, as well as to ornaments on other bronze objects of the Dongson Culture, leaves no doubt as to the origin of this style. It must have been introduced during the Bronze Age, *i.e.* about the middle or during the second half of the first millennium B.C. This ornamental style of Bronze Age origin is found in a particularly vigorous and highly developed form in the arts of the Dayak of Borneo, the Batak and Minangkabauans of Sumatra, the Sa'dan Toradja of Celebes, the Ngada of Flores and the natives of Alor and the Tanimbar Islands, but there is hardly a region in Indonesia where its influence is not recognizable. This influence extends along the North Coast of New Guinea as far as the Trobriand Islands and has even penetrated into the Solomon Islands (175).

Two important papers along the same line of research were contributed by Vroklage and Steinmann. That of Vroklage deals with the connections between the ornamental style and the second (Metal Age) megalithic culture, while Steinmann discussed the survival of Dongson motives and designs in the textiles of Kroë in Southwest Sumatra (176).

On the basis of investigations which I carried on in recent years, but the results of which have not yet been published, I came to the conclusion that the ornamental styles of Indonesia are not merely of Dongson Culture origin, but can be traced back to two distinct sources. While the Dongson style survives in almost pure form in the arts of the Batak, Minangkabauans and Sa'dan Toradjas and in those of Alor and Tanimbar, the art styles of the Dayak of Borneo and of the Ngada of Flores seem to be derived mainly from the Late Chou style of China. Both the Dongson and Late Chou styles, which flourished at the same time and were in many respects related to each other, may have reached Indonesia roughly during the same period.

Not only do the recent art styles of many peoples of Indonesia perpetuate styles of art introduced in prehistoric times, but the latter's influence is clearly recognizable also in Javanese

buildings and sculptures of the Hindu-Buddhist period, especially of its final phase, when the old indigenous substratum gained more and more in importance. KROM and STUTTERHEIM have shown that Javanese terraced sanctuaries like those at Soekoeh, Tjeta, etc., all dating from the 14th and 15th centuries, are really Hinduized versions of the old megalithic type of terraced monuments (FIG. 50) (177). In a discussion of the subject I added a few new proofs which confirm these two authors' findings. I also tried to link the Javanese sepulchral bathing places of the 10th and 11th centuries to certain forms of megalithic monuments found among the mountain tribes of Assam and North Luzon and in the island of Nias, bathing places which at the same time serve as memorials to the dead. Further, I attempted to demonstrate that the Hindu-Sundanese sculptures of the 14th century contained elements derived from the primitive pre-Hindu stone ancestor figures of West Java (178).

KROM, STUTTERHEIM and others had repeatedly commented on the "Indonesian" character of East Javanese art, as contrasted to the classical Hindu character of the earlier, Central Javanese period. KROM had especially dwelt on the similarities of Central, as well as East Javanese decorative designs to those of Dayak and Batak art (179). On the basis of my studies on the Ornamental Style of Indonesia and its derivation from the art of the Dongson Culture, I pointed out that it was this style of Bronze Age origin which had influenced the Hindu-Buddhist art of East Java. Moreover, I suggested that the style of the Javanese Wayang puppets and of the reliefs on East Javanese temples, so completely different from that of the classical period, had been influenced by paintings similar to those of the Bataks and Dayaks, paintings which originally derive from those of the Dongson Culture (180). Lastly, I tried to show that the Kris Madjapahit, probably the oldest form of the Javanese kris, had developed from a bronze dagger type of the Dongson Culture which has been found in Tonkin and North Annam (181).

FIGURE 50. —TJANDI SOEKOEH, 15TH CENTURY A. D., CENTRAL JAVA. (*By courtesy of* DR. WILLEM F. STUTTERHEIM.)

**Discovery of the Palaeolithic:** — The discovery of Pleistocene races and cultures in Java by C. TER HAAR, OPPENOORTH, VON KOENIGSWALD, and their collaborators opened a completely new chapter in the history of prehistoric research in Indonesia. Until 1931 the only human remains of undoubted Pleistocene age known from this area were the *Pithecanthropus* skull and femur from Trinil and a mandible, also attributed to *Pithecanthropus*, from Kendeng Broeboes. The two Wadjak skulls, although considered by DUBOIS as being probably of Pleistocene age, could not be dated with certainty. Not a single artifact of the Pleistocene period had as yet been discovered.

This situation changed radically, when in 1931 and the following years, C. TER HAAR, VON KOENIGSWALD and OPPENOORTH found parts of eleven human skulls and one tibia in a river terrace of the Solo River valley near Ngandong in Central Java. The stratum from which these remains were excavated dates from the middle part of the Upper Pleistocene and is said to correspond to the Third Interglacial (182). Whereas VALLOIS and VON KOENIGSWALD ascribed the Ngandong skulls to a local variant of Neanderthal Man, OPPENOORTH pointed out important differences from the latter, and considered *Homo soloensis*, as he termed this new human race, as a distinct form descended from *Pithecanthropus* (183). His view has been confirmed by WEIDENREICH, who came to the conclusion that "*Homo soloensis* cannot be placed in the Neanderthal group, but represents a rather more primitive type" and

that he is "an enlarged *Pithecanthropus* type on the way to an advanced form" (184).

The discovery of *Homo soloensis* was followed by that of an infantile skull in a stratum of the Early Pleistocene Djetis period near Modjokerto in East Java (185). It is the skull of a *Pithecanthropus* child, but on account of its infantile character, it is not possible to determine to which of the three *Pithecanthropus* races or stages, distinguished by WEIDENREICH, it belongs (186). This skull of *Homo modjokertensis* may be considered as being the oldest geologically datable human remain hitherto found in Asia.

In 1938 and 1939 VON KOENIGSWALD discovered in rapid succession three skulls, a maxilla and a mandible of *Pithecanthropus*, all dating from the Middle Pleistocene Trinil period which had already yielded DUBOIS' first *Pithecanthropus* find (187). In 1941, he was able to add the fragment of a mandible of a giant hominid, whom he distinguished as a special form, and termed *Meganthropus palaeo-javanicus*. Detailed studies of these human remains were made by WEIDENREICH, who came to the conclusion that they represent three races, or rather three stages of development, *Meganthropus*, *Pithecanthropus robustus* and, the furthest developed of the three, *Pithecanthropus erectus*. According to WEIDENREICH, *Meganthropus* is a descendant of *Gigantopithecus*, known only by three teeth from caves in South China and in reality a hominid who should be termed more correctly *Gigantanthropus* (188).

Recently, new light has also been shed on the age of Wadjak man. A skull of *Homo sapiens*, found at Keilor, near Melbourne in Australia, has been said to date from the last Interglacial (189). According to WEIDENREICH, the skull corresponds in the most minute details to the skulls from Wadjak (190). Although the attribution of the Keilor skull to the last Interglacial cannot yet be accepted as definite, we can hardly doubt that it actually dates from the Late Pleistocene, be it from the Third Interglacial or from the Fourth Glaciation. This would indicate that in Java, too, Wadjak Man existed during the Late Pleistocene, although it is, of course, possible that he survived into the early Holocene.

Simultaneously with these discoveries of prehistoric races, the outlines of the cultural history of Java during the Pleistocene period began slowly to emerge. The first artifacts of Pleistocene age ever to be discovered in the soil of Indonesia were found in the Late Pleistocene stratum at Ngandong in the Solo River Valley, which had yielded the skulls of *Homo soloensis*, and in strata of the same geological age at nearby Watoealang. Most conspicuous among them are a kind of hammers or hoes made from the antlers of a Pleistocene deer, *Axis Lydekkeri*. They further comprise pieces of broken pipe bones, some of which seem to have been intentionally fashioned for use as spatulae or pointed weapons, tail stings of rays which may have served as daggers or spear heads, balls of andesit and a variety of stone tools, mostly scrapers or flakes (FIG. 51) (191). Unfortunately, the excavations were carried out in a completely unsystematic and unscientific manner, rightly criticized by VAN STEIN CALLENFELS and others (192). As a result, we have so far no way of telling whether the finds belong to a single culture or to a series of different periods and cultures, nor whether any among them, and if so, which, represent the culture of *Homo soloensis*. VAN STEIN CALLENFELS was probably right in suggesting that they may come from civilizations typologically and chronologically far apart (193).

A unique item, a bone spear head with a double row of barbs, is said to have been found at Sidoredjo in the Solo River valley in a stratum dating from the very end of the Pleistocene (194). It is decidedly later than the Ngandong stratum and it was only by error that VAN STEIN CALLENFELS, and on the latter's authority also the author, ascribed it to Solo Man with whom it certainly has nothing to do (FIG. 51).

In 1934, VON KOENIGSWALD found at Sangiran near Soerakarta in Middle Java small flakes, blades, points, scrapers and cores of chalcedony or other silicified material "associated with a fauna typical of the Trinil horizon." However, he pointed out that these tools all came from the upper part of the Middle Pleistocene stratum, whereas the skulls and other remains of *Pithecanthropus* discovered at the same place were all found in its lower part. At first he expressed the opinion that the implements could not be ascribed to *Pithecanthropus*, as they were typologically too advanced. Subsequently, he changed his view and considered the possibility that the Sangiran tools were indeed those of *Pithecanthropus* (195).

The attribution of the Sangiran artifacts to the Trinil period was criticized by TEILHARD DE CHARDIN, who ascribed the stratum in which they had been found to the Late Pleistocene and thought that it was more or less contemporary with the Ngandong layers which had yielded the remains of *Homo soloensis* His view was confirmed by DE TERRA, who, when he investigated the site, found no stone tools in the Middle Pleistocene stratum, but only in the overlying Late Pleistocene Notopoero Beds. By reason of the stratigraphical conditions, as well as of their typological character, DE TERRA assigned the Sangiran implements and the similar ones which he and MOVIUS found on the surface near Karsono in the Solo River valley to the Late Pleistocene and suggested that they may possibly be connected with *Homo soloensis* (196). This is in accordance with VAN STEIN CALLENFELS' observation, who remarked that the allegedly Middle Pleistocene stone tools of Sangiran are "practically identical" in character with those from the Late Pleistocene Ngandong layers (197).

A further step forward in our knowledge of the palaeolithic cultures of Java came in 1935, when VON KOENIGSWALD and TWEEDIE discovered in the surroundings of Patjitan, near the South coast of Central Java, large, rough stone tools comprising scrapers, choppers and hand-axes (FIGS. 52, 53) (198). Since these tools were all found on the surface, their age cannot yet be determined with any degree of certainty. According to VON KOENIGSWALD's original view, they must have been washed out from a stratum not later than the Trinil period, *i.e.* the earlier part of the Middle Pleistocene, the age of *Pithecanthropus*. Later, he is said to have changed his opinion and to believe now that they may date from several different geological periods (199).

From the very beginning, VON KOENIGSWALD wished to exclude the possibility that the Patjitan tools represent the culture of *Pithecanthropus*, as he thought that they were too advanced in type. His conclusion was that a race of men physically and culturally more developed than *Pithecanthropus* must have lived side by side with the lat-

ter in the Middle Pleistocene of Java (200). Both he and VAN DER HOOP classed the Patjitan culture as a branch of the Chellean (201).

DE TERRA is inclined to date the Patjitan tools in the late Middle Pleistocene or the early Late Pleistocene (202). VAN STEIN CALLENFELS discussed the possibility that they may date from the Late Pleistocene Ngandong period and represent the culture of *Homo soloensis*, an assumption for which there is, however, so far not the least evidence (203).

The Chellean character of the Patjitan culture was questioned by MOVIUS and DE TERRA, who want to link it rather to the chopping tool industries of South and East Asia, the Kota Tampan culture of the Malay Peninsula, the Anyathian of Upper Burma, the Early Soan of Northwest India and the *Sinanthropus* culture of Choukoutien (204). The possibility of such connections have been admitted also by TEILHARD DE CHARDIN (205). By reason of its supposed geological age and of its typological character, MOVIUS considered it as probable that the culture of Patjitan was that of *Pithecanthropus* or at least of the latter's direct descendants: a view adopted also by HOOTON, who thinks that all the chopping tool industries of southern and eastern Asia represent the cultures of men of the *Pithecanthropus-Sinanthropus* stage of evolution (206).

Stone tools similar to those from Patjitan have since been found at various places in the vicinity, further near Parigi and Gombong in southern Central Java, near Soekaboemi in West Java and near Tambangsawah in the Residency Benkoelen in West Sumatra (207). Since all specimens were picked up from the surface, their geological age cannot yet be determined.

As a result of all these discoveries, we now have thousands of stone tools of distinctly early palaeolithic character, supposedly dating from the Middle or the beginning of the Late Pleistocene. They may, perhaps, be products of the industry of *Pithecanthropus* All this is, however, still quite uncertain. The sober truth is that we have, so far, no proof of their geological age; that we even do not know whether the Patjitan tools belong all to a single culture or to a series of subsequent cultures, a possibility already admitted by VON KOENIGSWALD (208).

In concluding this chapter, the important progress made in recent years in the establishment of the outlines of the geological stratigraphy and chronology of Java should be mentioned. Even the scant knowledge we have of the chronology of palaeolithic cultures in that island could never have been attained without the help of the fundamental geological investigations of VON KOENIGSWALD, DE TERRA and other geologists (209).

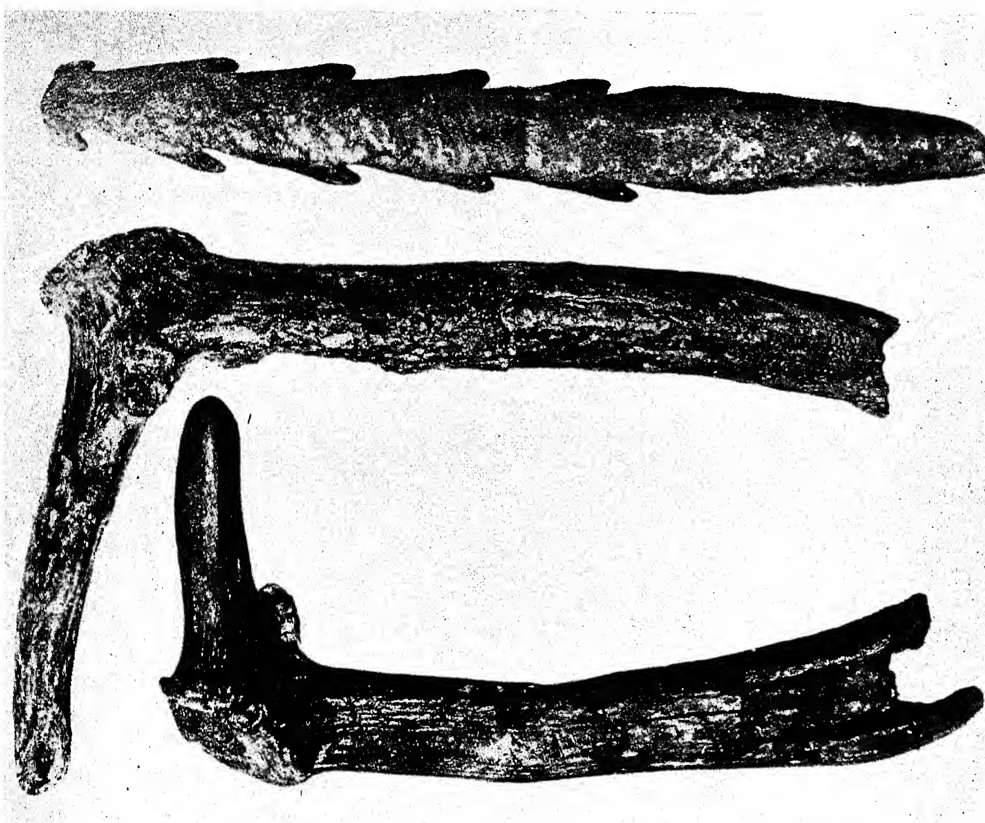

FIGURE 51. — TWO IMPLEMENTS OF DEERHORN FROM NGANDONG AND BARBED SPEARHEAD FROM SIDOREDJO, CENTRAL JAVA. (*From* VAN STEIN CALLENFELS, 1936*d*.)

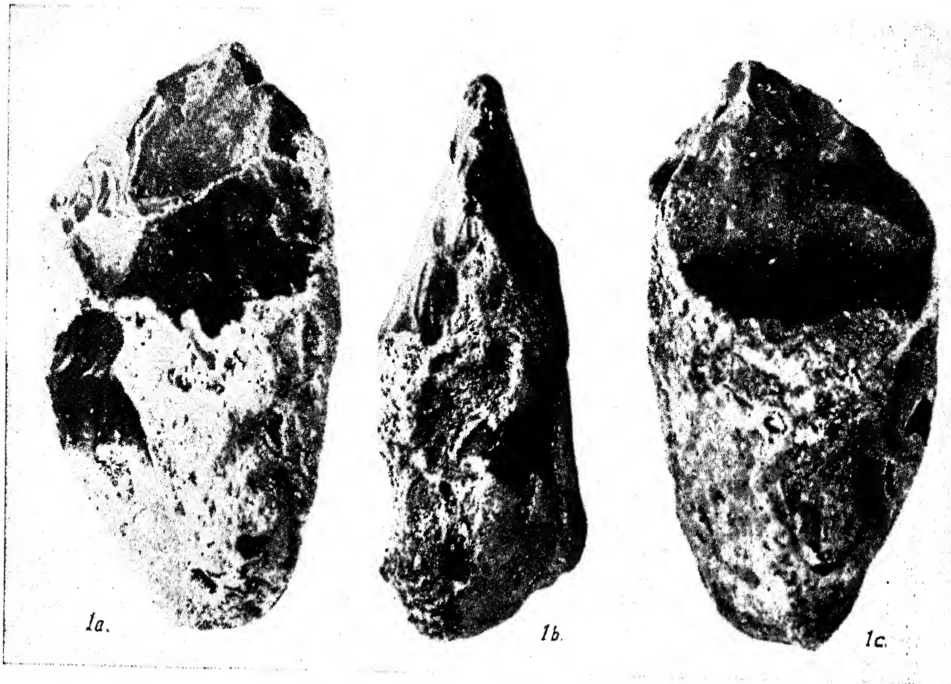


Figure 52. — Palaeolithic implement from the region of Patjitan, Java. *(From* von Koenigswald, 1936*d*.)

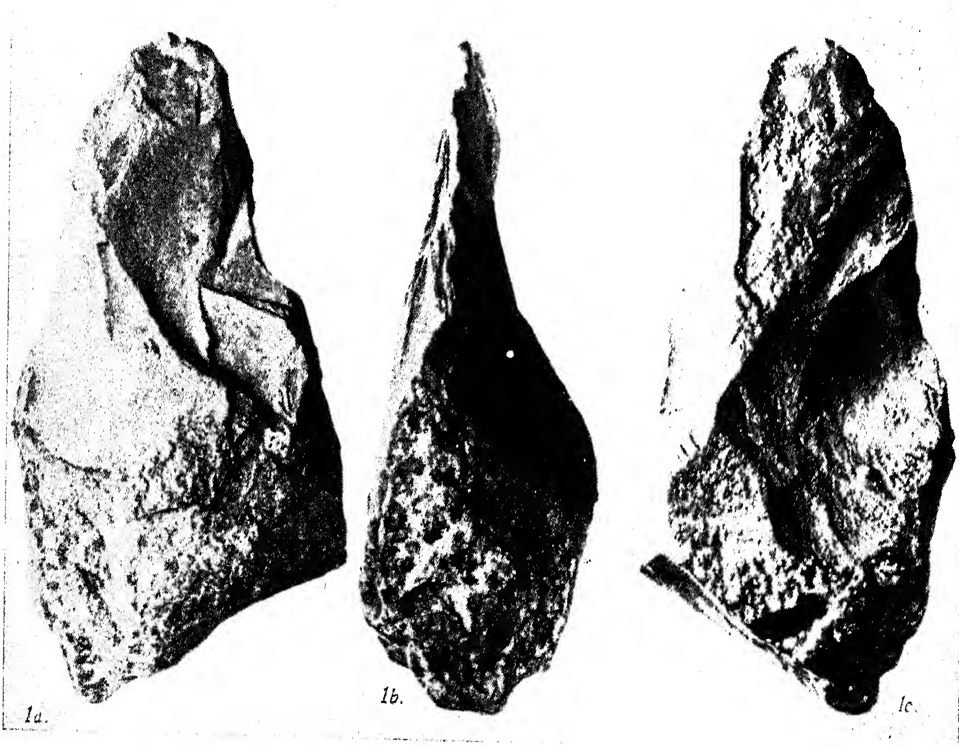


Figure 53. — Palaeolithic implement from the region of Patjitan. ? *(From* von Koenigswald, 1936*d*.)

**Progress and Organization of Research:** — A comparison of the results of excavations and comparative studies listed in this paper, with the pitiably small knowledge we had of the prehistory of Indonesia when, little more than twenty years ago, I published the first general survey of the subject (210), will clearly show the vast strides forward that have been made in this field. The rapidity of progress, especially during the decade preceding the present war, may be illustrated by the following facts.

When I published an account of the Stone Age of Indonesia in 1932, I could not list a single tool of Pleistocene age. Three years later, a large quantity of such tools, belonging to a variety of cultures, were known. In 1938, they could already be counted by the thousand.

When the prehistoric collection of the Batavian Society was installed as a separate unit ten years ago, it comprised 1506 items. By the end of 1940 their number had risen to 5371 and thus had been more than trebled (211).

In a bibliography covering the years from the beginning of 1928 to the middle of 1936, I was able to list more than seventy titles of books and articles dealing with the prehistory of the Archipelago (212).

Under these circumstances it is no wonder that the various surveys of our knowledge of the prehistory of Indonesia, which were published since 1926, were usually out of date within a very short period, some of them, in fact, even at the time of their publication (213). If VAN DER HOOP's excellent contribution to STAPEL's "Geschiedenis van Nederlandsch-Indië" and the author's short article, written for the forthcoming edition of Encyclopaedia Britannica, do not share the fate of those previous papers, this will be due solely to the interruption of research by the war (214).

During the fifteen years preceding the Japanese invasion, comparative studies carried out by VAN STEIN CALLENFELS, VAN DER HOOP and the author succeeded in drawing the outlines of the prehistory of Indonesia, incomplete and vague though they still are in many respects. This could not have been achieved without the great progress made by prehistoric research in neighboring areas, above all in the Malay Peninsula and in French Indo-China, during the last two decades.

The importance of coordinating the results of research in Indonesia with those in other parts of Southeast and East Asia was early realized by VAN STEIN CALLENFELS. He visited the Philippines, Japan and French Indo-China in order to obtain first-hand knowledge of the prehistoric cultures of these areas (215). Moreover, he himself took an active part in excavations in the Malay Peninsula (216). His stimulating influence was felt all over Southeast Asia and contributed greatly to the introduction of more scientific methods of excavation in that part of the world.

As a further means of mutual coöperation and exchange of knowledge, VAN STEIN CALLENFELS suggested the organization of a Congress of Prehistorians of the Far East, to be held every three years. The first session took place at Hanoi in 1932, the second at Manila in 1935, the third at Singapore in 1938 (217). Already fatally ill, VAN STEIN CALLENFELS still attended the Congress at Singapore and from there proceeded to Rangoon, to advise the Government of Burma on the promotion of prehistoric research. However, his health soon compelled him to leave for Europe. It was on his passage there that death overtook him at Colombo in Ceylon.

Still another step which was to prove of great importance for the advancement of prehistoric studies in Indonesia is due to VAN STEIN CALLENFELS: the organization of the prehistoric collections of the Museum of the Royal Batavian Society as a separate unit (218). The systematic study of the rich material thus brought together and scientifically classified has as yet hardly begun and promises to yield important results in years to come.

### III. THE FUTURE OF PREHISTORIC RESEARCH IN INDONESIA

The amount of work done during the fifteen years from 1926 to 1941 should not blind us to the fact that the enormous wealth of Indonesia in prehistoric remains has so far hardly been tapped. VON KOENIGSWALD's discovery of *Meganthropus* or, for instance, the finds of Han pottery in Sumatra, Java and Borneo, give an indication of the surprises we may expect if and when a more thorough and more systematic research is started.

However, before touching on the subject of future tasks and prospects, it seems advisable to discuss a few important principles and among others, to point out some of the mistakes of the past which should, if possible, be avoided.

**Conservation:** — Prehistoric dwelling sites in Southeast Asia are subject to grave dangers from industrial exploitation. Many of them contain enormous quantities of shells which may be extracted and used by local lime-burners. It is in this way that the larger part of the kitchen-middens in Province Wellesley, in the Malay Peninsula, and the famous neolithic and Bronze Age site of Samrong-sen in Cambodia were destroyed at a great loss to archaeology, since they had never been properly investigated.

When VAN STEIN CALLENFELS first heard of the kitchen-middens near Medan in Sumatra and visited one of them in 1920, he found people busy digging into it and carrying off the material, in order to use the shells for lime-burning. He warned that all the shell-heaps would eventually disappear if measures were not taken soon to protect them (219). In 1927 he observed that most of the kitchen-middens had been destroyed before they had been brought to the notice of the Archaeological Service (220). When SCHÜRMANN started to excavate the shell-heap at Bindjai Tamiang, only the lower third of it was still in existence (221).

Not even prehistoric deposits in caves are safe from similar dangers. Before those in the Goewa Lawa near Sampoeng had come to the notice of VAN Es and VAN STEIN CALLENFELS, a considerable part of them had been destroyed, the earth, which is rich in bat dung, having been extracted for use as manure on a sugar plantation (222).

When, as a result of VAN STEIN CALLENFELS' activities, interest in the prehistory of the Archipelago had at last been aroused, the Archaeological Service proceeded to take measures in order to stop further destruction of prehistoric monuments. Since at that time no efficient legal basis for this purpose was as yet in existence, local officials were asked to take a number of specified sites and monuments under their protection (223). After the promulgation of the Monumenten-Ordonnantie in 1931, it became possible to put such sites and monuments on the list of protected monuments (224). In some cases, special steps had to be taken. Thus, the Archaeological Service succeeded in inducing a firm which had already been granted the right to exploit some caves near Toeban and Bodjonegoro in Java, to postpone such exploitation until the caves had been investigated archaeologically (225).

The conservation of megalithic monuments and of prehistoric stone sculptures poses a particularly difficult problem, as they are not only subject to the deteriorating influences of the tropical climate, but are also constantly exposed to wanton destruction by inconsiderate persons. One need only compare DE JONG's description of the monu-

ments on the Argapoera with that of KOHLBRUGGE in order to see how much they had changed for the worse in the course of forty years (226). The archaeological report of 1921 complains about the very bad state of the large group of primitive stone images near Buitenzorg, known as Artja Domas (227). That of 1929 tells of a megalithic grave in Apo Kajan, Central Borneo, which is gradually being destroyed, it having become a custom among native visitors from Sarawak to break off pieces of the stone as souvenirs, possibly on account of some alleged magical qualities (228). In 1936, a Dutch official in Sumatra decried the state of neglect of the Pasemah sculptures. He observed that not much had been achieved by simply putting them on the list of protected monuments and indicated how they could be effectively protected and preserved at very little cost (229). Although it must be realized how heavily the personnel and the means of the Archaeological Service of the Netherlands Indies are being taxed by the care for Hindu-Buddhist and Mohammedan monuments, we may express the hope that in the future more attention will be devoted also to the monuments dating from prehistoric periods. A good beginning in this respect has already been made by the restoration and conservation of some megalithic tombs in East Java (230).

**Prevention of Unscientific Excavations:** — One of the most important tasks of the Archaeological Service is the prevention of unauthorized excavations. Of course, it will never be possible completely to prevent the clandestine looting of prehistoric graves for gold or other valuable objects (231). However, the one thing that can be stopped is excavation by well meaning and enthusiastic amateurs who lack the training and knowledge necessary for the successful execution of such an undertaking along scientific lines. In this respect, much harm has been done in the past. To quote only a few instances, we are told that in 1921 two megalithic tombs in East Java had been opened by a local official who extracted a number of glass beads, sherds and human teeth. No further details are given. In 1924, VAN STEIN CALLENFELS complained bitterly about the fact that the majority of megalithic tombs at Pakahoeman in East Java had been "excavated" by unqualified amateurs and thereby had become practically valueless from the point of view of archaeology. Similarly, the urn field cemetery of Melolo on the island of Soemba has been in part destroyed by unscientific excavation (232).

Fortunately, the new law on the protection of monuments, the Monumenten-Ordonnantie of 1931, stipulates that no excavation may be undertaken without a written permit from the head of the Archaeological Service. However, it must be said that the most serious case of unscientific excavation of a prehistoric site occurred after the promulgation of that law and, what is even more aggravating, under the sponsorship of a Government Department, the Mijnbouwkundige Dienst (Geological Service). I refer to the excavations at Ngandong, Watoealang and Sidoredjo in the Solo River Valley in Central Java. It will be remembered that it was at Ngandong that the skulls of *Homo soloensis* were found, while all three sites yielded cultural remains dating from the Late Pleistocene (see above pp. 153 and 154). OPPENOORTH himself tells how the excavations were carried out under the supervision of some "native young men" who had to send weekly reports, while he, OPPENOORTH, paid short visits to the sites at longer intervals (233). His brief report contains practically nothing about the stratigraphy. We are told that artifacts were found in the same stratum as the skulls, but also in other places and on the surface. OPPENOORTH assures us that the artifacts and skulls date from the same period, an assertion which, from the geological point of view, is probably correct. However, he seems to have been completely unaware of the fact that, what to the geologist and palaeontologist is one period, may comprise a whole series of subsequent cultural periods. Nothing is more revealing in this respect than the rather naïve statement, made in support of the alleged contemporaneousness of artifacts and skulls, that a ray sting (probably used as a dagger or spearhead) was found at a distance of "only" ten meters from one of the skulls (234). Every prehistorian knows, of course, that a distance of ten meters, even in a horizontal direction, may or may not, according to circumstances, represent a difference in age of thousands or even ten thousands of years.

In reality, things seem to have been even worse than would appear from OPPENOORTH'S own report. For this we may quote the following statement by VAN STEIN CALLENFELS: "Unfortunately the excavations at Ngandong and other places in 1931–33 were carried out in a very unscientific way, their supervision being left to native surveyors who were quite ignorant of prehistory, palaeoanthropology and prehistoric research methods, and TEILHARD DE CHARDIN informed me that Dr. VON KOENIGSWALD had told him that the spear head (*i.e.* the barbed bone spear head from Sidoredjo) was discovered in the Bandoeng Museum in a box together with fossil bones, etc., sent over by one of these same surveyors" (235). The fact, that the bone and antler implements from the Solo River valley were not recognized as such when found, but were subsequently discovered among the fossil bones sent to the Museum at Bandoeng, has been mentioned also by TEILHARD DE CHARDIN and by L. ADAM (236).

As a result of such methods, we have no means of telling whether the stone, bone and antler tools from Ngandong and other places in the Solo River valley represent one single culture or a whole sequence of cultures. Nor is it possible to decide with any degree of certainty whether any of them, and if so, which, were made and used by *Homo soloensis*. Even worse, some of the most important prehistoric sites have been either completely or in large part destroyed and the information they could have yielded on the cultural history of Indonesia has been lost forever.

It cannot be stressed strongly enough that geological methods are completely inadequate, as far as prehistoric remains are concerned. It should be made a rule that if and when human skelettal remains or artifacts are discovered in the course of geological investigations, excavation should be immediately stopped until such time when it can be continued under the supervision of a trained prehistorian.

**Publication of Discoveries:** — Excessive delay in the publication of the results of their excavations is a rather frequent failing of archaeologists all over the world. To this, the Netherlands Indies forms no exception. It will suffice to quote a few instances.

During the years 1925 and 1926 the reports of the Archaeological Service mentioned repeatedly the excavation of a shell heap near Saentis, on the East Coast of Sumatra, by VAN STEIN CALLENFELS. It was promised that a detailed report would appear, as soon as the excavation was completed (237). This report has never been published.

Practically nothing was published on the excavation of Toalian and Proto-Toalian sites in South Celebes, carried out by VAN STEIN CALLENFELS and WILLEMS, and the same holds good of the excavation of the Toeban caves by WILLEMS (238).

VAN STEIN CALLENFELS' article on the excavation of the Goewa Lawa near Sampoeng is termed "Preliminary Notes," which would seem to imply that a final report had been planned (239). Such a report has never been published.

By far the most serious case is VAN STEIN CALLENFELS' failure to have published anything on his excavations at Galoempang in West Central Celebes. Owing to his death, there is little hope of any further information on this site being supplied, except perhaps by new excavations. As a result, we have only a few very superficial remarks, in fact no more than a few lines, and a small number of illustrations to rely upon (240). This is the more regrettable, as the finds of Galoempang are doubly important from the point of view of connections with the mainland of Asia and with Japan and as a sample of the parent culture from which East Polynesian culture originated (see above p. 142).

It would be unjust to lay the whole blame for these deficiencies on the prehistorians. The fact is that men like VAN STEIN CALLENFELS, VAN DER HOOP and WILLEMS had, and in the future will have again, such an enormous area to cover and such a multiplicity of tasks to attend to, comprising exploration, excavation, supervision of monuments, conservation and museum work, that they have very little time left for adequate publication of the results of their work. Nor should the Archaeological Service be blamed, since, in spite of severe curtailment of funds, it has, in recent years, shown a most commendable interest in the prehistory of the Archipelago. I shall revert to this point later and try to indicate a remedy for the situation.

Of course, there can hardly be an excuse for such delays as the publication of the Kendeng Broeboes mandible of *Pithecanthropus*, thirty-four years after it had been found (241). Even worse is the case of the Wadjak skulls. The first of these skulls was found by B. D. VAN RIETSCHOTEN in 1889, while prospecting for marble. EUGEN DUBOIS recognized its importance immediately and in the following year himself undertook excavations at the site, which yielded a second skull. Yet it took thirty years till he published descriptions (242). In the meantime, the site had been completely destroyed in the course of quarrying marble (243). An earlier publication might have stimulated new excavations there which might have yielded further material.

On the other hand, VAN DER HOOP's brilliant and exhaustive book on the megaliths of South Sumatra may be quoted as an outstanding example of early publication. It came out only one year after the author's expedition, a really remarkable achievement of speedy work (244).

On the whole, however, the importance of making new discoveries known as soon as possible should be given somewhat more consideration. Since excavations can be undertaken only after receiving a written permit from the head of the Archaeological Service, it could easily be made a rule to grant such permits only on condition that the persons to whom they are given undertake to submit a preliminary report within half a year after each campaign and a final report within a reasonable period, say two to three years, after having concluded the excavation of the respective site.

May I further avail myself of this opportunity to bring to the notice of prehistorians and palaeo-anthropologists in Indonesia the desirability of publishing their reports in periodicals not too difficult to procure in other countries. The Netherlands and the Netherlands East Indies are unusually rich in magnificent scientific periodicals which are to be found in practically every large American or European library. Yet, some important papers, as, for instance, ZWIERZYCKI's report on his excavation of a cave in Sumatra, have been published exclusively in such periodicals as "De Ingenieur in Nederlandsch-Indië" or "De Mijningenieur," which are practically inaccessible outside the Netherlands and the Netherlands Indies, and are therefore more or less lost to science.

**Research:** — Opportunities for prehistoric research in Indonesia are almost limitless. The following notes are intended to give no more than a general idea of at least a few of the most important problems awaiting elucidation.

One of the most puzzling questions is that of the culture of *Pithecanthropus*. So far, no artifacts have been found with the latter's bodily remains, and we can only infer by way of analogy with the closely related *Sinanthropus* that he, too, knew the use of tools and of fire. The question whether the rough chopping-tools, hand-axes and scrapers from the region of Patjitan and from other places in Java might belong to this hypothetical *Pithecanthropus* culture, has been discussed by various authors. However, we do not even know for certain from which geological period they date, nor whether they represent a single culture or a sequence of cultures. Excavations at the relevant sites would, therefore, seem to be among the most important tasks of future research.

The finds reported from Ngandong, Watoeala and Ngansinan in the Solo River valley comprise a variety of tools and weapons of stone, bone, deer-horn and ray-sting, all dating from the Late Pleistocene, but here again we do not know whether we have to deal with a single culture or with several culture periods. New excavations at these sites are therefore highly desirable. We may hope that the latter have not been completely destroyed by the previous digging for fossil remains.

At Sangiran in Central Java, attention should be directed not only to the lower (Middle Pleistocene) layers, important on account of the *Pithecanthropus* remains which they have yielded, but also to the upper (Late Pleistocene) strata, which contain stone tools.

The barbed bone spear-head from Sidoredjo indicates the existence of an otherwise unknown culture from the very end of the Pleistocene. There would seem to be some chance of discovering further traces of this culture in the Solo River valley. Might it have been the culture of Wadjak Man?

With regard to the mesolithic hand-ax culture, the kitchen-middens of North Sumatra seem still to offer the best prospect for obtaining further information. Although a number of papers have been published on the subject, we have so far not a single really satisfactory report. However, three as yet untouched middens are said to exist in the Tamiang District of Atjeh (245). We may hope that they will be scientifically excavated and will at last furnish reliable data on that important culture.

A reexamination of the sites around Bandoeng, where obsidian microliths were found, would be desirable, in order to ascertain whether the culture in question is really neolithic, as has been contended by several scholars, or mesolithic, as seems more probable. Even better information concerning this culture may be expected from the excavation of caves in Sumatra, where it has been shown to occur.

The caves and rock-shelters on the islands of Roti and Timor, where BÜHLER excavated, should be investigated afresh, the more so as the chronological position of BÜHLER's finds is still quite uncertain. A beginning was made by preliminary explorations on Timor, undertaken by the Archaeological Service in 1939 (246).

The influence of the Timor Culture, and indeed of the whole Proto-Toalian and Toalian group of cultures, on the native cultures of North Australia might become a promising subject of comparative research.

Some of the many problems relating to the neolithic cultures of Indonesia have been discussed above. A more thorough investigation of neolithic workshops might yield important clues about the chronological phases of the Quadrangular Adze Culture and may be expected to establish definitely the chronological relationship between the latter and the culture characterized by the occurrence of stone arrow heads. Even more important is the search for neolithic dwelling place sites and neolithic graves (see above p. 134).

New investigations are needed at the important sites near Galoempang in Celebes. It seems improbable that they have been completely exhausted by VAN STEIN CALLENFELS' previous excavations, the results of which have unfortunately never been published.

Practically nothing is known of the Round-Ax Culture, so important because of the light it could throw on the origin of the recent cultures of New Guinea and Melanesia. The fact that some round-axes are said to have been actually found in graves in the Minahassa district of North Celebes, sounds rather hopeful (247). It should prove possible to trace further graves in that region.

Nothing whatever is known of the prehistory of the islands west of Sumatra: Nias, Mentawei, Engano. Even a rather superficial exploration would probably reveal the former existence of neolithic cultures.

The systematic investigation of megalithic monuments has so far hardly begun. In view of their enormous number, only a few hints can be given here. Research on the older monuments of Nias, Soemba and Flores would, no doubt, yield important clues with regard to the spread and development of megaliths in Indonesia. Indeed, ancient monuments of this class have been reported from Flores. The occurrence of Chinese and Siamese earthenware and porcelain sherds in their vicinity makes it possible to date them with some probability in the 13th and 14th centuries (248). They seem to show special affinity to the megaliths of Nias, a fact of significance in view of the existence of various highly specialized elements common to the recent cultures of the two islands. In Borneo, a closer research in the region of Apo Kajan, where SIEREVELT found stone graves and primitive sculptures, would probably bring to light more monuments of the same kind (249). In Java the existence of intact megalithic tombs in the region of Bodjonegoro has been reported recently (250).

Great surprises may be expected from the systematic investigation of Bronze Age sites. In this respect, the region of Kerintji in Central Sumatra would seem to be particularly promising (251). However, the influence of the Dongson style is so conspicuous in the recent art styles of the Batak, the Minangkabauans and the people of Kroë that it seems reasonable to hope for the eventual discovery of Bronze Age sites in all these regions of Sumatra. What may possibly be a Bronze Age urn burial cemetery has been reported from Tebing Tinggi in South Sumatra (252). Its investigation and eventual excavation is highly desirable.

A thorough search for Bronze Age sites should be made in the region of Lake Sentani in Netherlands New Guinea,

where VAN DER SANDE obtained bronze socketed celts (253). However, here too the close relation of recent art styles along most of the North Coast of New Guinea with the style of the Dongson Culture and, moreover, the frequency of antique glass beads and glass rings in the same region, indicate a much larger extension of the ancient Bronze Age culture. For similar reasons, the former existence of centers of the Bronze Age Dongson Culture may be suspected in Southwest and West Central Celebes and on such islands as Alor and Tanimbar.

The prehistory of Borneo is as yet almost a blank. The very close connections between the recent art styles of the Dayak tribes and Late Chou Chinese art seem to justify the expectation that some day Chinese remains of the Late Chou Period will actually be found on that island. The same may be said of that part of Flores inhabited by the Ngada tribe.

So far, very little is known about the Han pottery which a few years ago has been found in Indonesia. The report on the ceramic collection of the Royal Batavian Society for 1934 tells us that such pottery had been brought to light by "recent excavations" in West Bantam (Java), in northeastern Lampong (Sumatra), in the Batang Hari District (Sumatra) and in West Borneo. The word "excavations" raised hopes of systematic investigations. However, such hopes were destroyed by the report for 1937, where we are told that these "excavations" were carried out in a completely unscientific manner and that the specimens recovered were almost without exception accidental finds. The report for 1938 describes and illustrates a Han vessel with an inscribed date (45 B.C.) which had been "excavated" near the upper course of the Soengai Merangin, on the border of Kerintji and Upper Djambi, Sumatra (254). It is hardly conceivable that where accidental finds brought to light such a considerable number of Han vessels, systematic research would not yield a by far larger quantity of Han pottery and perhaps other objects as well. The subject is of great significance for the cultural history not only of Indonesia, but of the whole of eastern and southern Asia, and calls for scientific excavations at the sites from which the finds of Han vessels have been reported.

These Chinese contacts of Han times, which must have preceded the beginning of Hindu colonization only by a very short interval, bring us to the threshold of the historic period. PTOLEMY's geography as well as Chinese reports seem to indicate that Hindu colonies had been established in Java by the 2nd century A.D. Yet, archaeologically, there still exists a gap between the remains of the Han Period and the earliest Hindu inscriptions of the 4th or 5th century A.D. A combination of luck and systematic research may some day succeed in filling this gap, so that it will become possible to write a continuous cultural history of Indonesia from prehistoric times to the present.

It is a vast and rich field that awaits the prehistorians of the future in Indonesia. We may well ask, whether it will be possible for the two official prehistorians, attached, one to the Archaeological Service, the other to the Museum of the Royal Batavian Society, to attend to it effectively without outside help. The work they have accomplished is admirable, but their task is too enormous. In the past, they were fortunate in having been able to enlist the help of a geologist, interested in palaeo-anthropology and prehistory, R. VON KOENIGSWALD, and that of an enthusiastic and competent amateur prehistorian, H. R. VAN HEEKEREN. A glance at the bibliography at the end of this paper will show how large the share of these two men is in the discoveries made in recent years. Even so, many important and urgent tasks could not be attended to. In many parts of the Archipelago not even the most preliminary explorations have been made so far. Many accidental discoveries, like, for instance, that of Han pottery in Sumatra and Java, could not be followed up by immediate systematic research. The results of a number of excavations, some of which date back many years, have not yet been published.

It can hardly be expected that the Netherlands Indies Government will in the near future be able to increase substantially the staff of its Archaeological Service. Moreover, the Archaeological Service will no doubt for years to come be fully occupied with the reorganization of supervision and conservation, disrupted by the war. In the meantime, scientific exploration will stop entirely or at least be severely handicapped. Many an opportunity of scientific research will be lost forever by the destruction of monuments, the looting of graves and the dispersal of accidental finds.

The only possibility to remedy that situation, at least to some extent, would seem to be international coöperation. American archaeological expeditions have for many years been working in Ireland, in Czechoslovakia, Yugoslavia, Greece and Egypt, in the Near East and in India, with the approval and the coöperation of the authorities and the archaeologists of those countries. May I suggest that in the future American Universities, Museums and Foundations extend their interest also to the prehistoric archaeology of the Netherlands Indies? Indeed, some beginnings in this respect have already been made. VON KOENIGSWALD's researches have been helped by grants from the Carnegie Institution of Washington and from the Cenozoic Research Laboratory of Peking, financed by the Rockefeller Foundation. The valuable results of the brief visit to Java of the American Southeast Asiatic Expedition on Early Man (H. DE TERRA and H. L. MOVIUS) may also be mentioned.

The best plan would seem to be for the prehistorians of the Netherlands Indies to indicate such sites which, in their opinion, would warrant large scale excavation with the coöperation of American archaeologists. The finds could be divided between Netherlands Indies and American Museums, as has been done in similar cases in Europe, the Near East and India. In view of the wealth of Indonesia in prehistoric objects this could hardly be conceived as implying a loss to the Netherlands Indies. On the contrary, it would greatly help and stimulate comparative research.

Another way of coöperation would be the granting of fellowships to American archaeologists who for one or several years might be attached to the Archaeological Service of the Netherlands Indies, thereby being enabled to gain first-hand knowledge of the subject while, at the same time, helping the Netherlands Indies prehistorians in their vast task.

I have little doubt that such arrangements would be welcome to all concerned. On the basis of personal discussions, as well as of correspondence carried on through many years, I know that they would have met the wholehearted approval of the man who laid the foundation of prehistoric research in Indonesia: P. V. VAN STEIN CALLENFELS.

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*Abbreviations*

BRM: Bulletin of the Raffles Museum, Singapore, Series B.
BTLVNI: Bijdragen tot de Taal-, Land- en Volkenkunde van Nederlandsch-Indië.
IAE: Internationales Archiv für Ethnographie.
KAWAP: Koninklijke Akademie van Wetenschappen te Amsterdam, Proceedings of the Section on Sciences.
KBGJ: Koninklijk Bataviaasch Genootschap van Kunsten en Wetenschappen, Jaarboek.
NBG: Notulen van de Algemeene en Directiever-

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# RESEARCH ON FISH AND FISHERIES IN THE INDO-AUSTRALIAN ARCHIPELAGO

*by*

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The richest and most varied marine fish fauna of the world is that of the East Indies, or Indo-Australian Archipelago. No other region ranks with it in the number of kinds of fishes and their extraordinary diversification. This biologic province extends from New Guinea and the Aru Islands on the east to the Andaman Islands in the Bay of Bengal on the west, and throughout the Philippines on the north. The Malay Peninsula is an integral part of the province, and was once united with Sumatra, Java, Borneo, and Palawan Province in the Sunda Land of MOLENGRAAFF. The rich fish fauna of the streams of these islands shows this, the same species occurring largely throughout the area, including Malaya.

From the time of the earliest Dutch settlements in the East Indies, the fishes of the coral reefs commanded attention. Their rich and kaleidoscopic colors or bizarre shapes interested all, so that many became known to Europeans at an early date. As the early Dutch, English, and French explorers of the south Pacific, and the great exploring and circumnavigating expeditions passed through the Indian islands they all collected fishes. These were studied and the results published, often with sumptuous illustrations. BLOCH, LACÉPÈDE, CUVIER and VALENCIENNES, and numerous other writers, described and figured many East Indian fishes.

In spite of all this, it was not until after that extraordinary man, PIETER BLEEKER, arrived

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."* — This article deals only with marine fisheries, and includes the entire East Indian region, and not merely the Netherlands Indies. The author has asked the editors of "Science and Scientists in the Netherlands East Indies" to state that he is not personally familiar with the work done in the years just preceding the war by the ichthyologists working with fresh water fisheries in the Netherlands Indies. For a short interesting account of certain aspects of inland fisheries in the Netherlands Indies see A. L. BUSCHKIEL 1929, Fish Culture (Fourth Pacific Science Congress, Exc. C. 4*a*). In 1926, when the author studied methods of pond culture in Java, nothing was being done to improve the ancient methods. This was changed in the years just preceding the war, when a number of able and well-trained young men were working to improve the methods of pond culture in Java and Sumatra and had already made considerable progress when the war came.

in Java in 1842 that an effort was made to study both intensively and extensively the marvellously rich fish fauna of the Indo-Australian archipelago. Until his premature death in 1878, BLEEKER poured out a wealth of papers on the fishes of the East Indies, besides making important contributions on the fishes of other regions. For the first time knowledge of East Indian fishes was placed on a sound scientific basis. The next worker to do serious studies of the East Indian fish fauna was Prof. MAX WEBER, who collected in the Archipelago in 1888, and in 1899–1900 headed the Siboga Expedition. In 1909–10 Dr. L. F. DE BEAUFORT, collaborator with Dr. WEBER in studying the Indo-Australian fishes, collected in the archipelago, particularly in the eastern part. WEBER and DE BEAUFORT began their invaluable work "Fishes of the Indo-Australian Archipelago" by a volume on the ichthyological papers of Dr. BLEEKER (1911). Dr. WEBER died in 1937, but the work is continued by Dr. DE BEAUFORT, the eighth volume appearing in 1940. The work of preparing a volume on the *Gobiidae, sensu lato,* the group with the largest number of species in the archipelago, was assigned by Dr. DE BEAUFORT to Dr. F. P. KOUMANS, who studied and collected in Java during June and July, 1938, while on a world tour to examine goby types. Dr. C. L. M. POPTA, of the Leiden Museum, described large collections and many new species from Borneo, the Sunda Islands, and Celebes, between 1900 and 1922. These fishes were obtained for her by Dr. A. W. NIEUWENHUIS and by the "Frankfurter Verein für Geographie."

A number of Dutch zoologists worked on fishes at the Fisheries Station, and after 1920 at the Laboratory for the Investigation of the Sea, at Batavia. Of these, Dr. H. C. DELSMAN and Dr. J. D. F. HARDENBERG were by far the most important. Dr. HARDENBERG has added much to the knowledge of East Indian fishes. His paper entitled "Marine Biological Research in the Dutch East Indies in the Last Three Decades" (1937), tells about the various members of the Station and Laboratory staff, and lists their publications. Dr. WALTER VOLZ, of Bern, Switzerland, spent two and a half years in southeast Sumatra, and in 1903 published a paper entitled "Fische von Sumatra." A year later he published another paper under the same title on the fishes collected by G. SCHNEIDER. These two papers added much to our knowledge of the fresh water fishes of Sumatra.

The fishes of Singapore were collected and studied by BLEEKER, and Count FRANCIS DE CASTELNAU also collected there and published two papers on them about 1860. Baron RANSONNET, German consul at Singapore, made a collection which the eminent FRANZ STEINDACHNER reported upon in 1870. In 1904 appeared a paper by GEORG DUNCKER, based on his collections made while a resident of Malaya. In recent years papers by AHL and the extensive collections by HERRE during 1931–1941 have added largely to the knowledge of the distribution of Indo-Australian fresh water fishes.

ALVIN SEALE, chief of the division of fisheries of the Bureau of Science, from 1907 to 1916, collected extensively throughout the Philippines and in North Borneo, adding to our knowledge of the distribution of East Indian fishes. During 1908–09 the U.S. Bureau of Fisheries vessel, the "Albatross," under the scientific direction of Dr. HUGH M. SMITH, made enormous collections in the Philippines, China Sea, and on the coasts of Borneo, Celebes, and the Moluccas. A number of papers on new species and genera were soon published by SMITH and LEWIS RADCLIFFE, but the collections were not really studied until HENRY W. FOWLER began work on them. Six volumes have been published thus far (1928–1941), with large additions to the known species and proportionate increases in our knowledge of the distribution of fishes.

In 1920 ALBERT W. C. T. HERRE became chief of the division of fishes in the Bureau of Science (1920–28), and collected (1920–1941), over much of the island world of the Pacific, from the Galapagos and the Carolines westward. His field work in East Indian waters ranged from the northern end of the Philippines to Borneo, the Malay Peninsula, Sumatra, Java, the Riouw Archipelago, the Sangir Islands, Celebes, the Moluccas, Waigiu, and New Guinea. He has published more than a hundred books and papers on Indo-Australian fishes and their distribution, and on tropical Pacific fisheries. From the beginning he made every effort to build up a native scientific staff. Carefully selected Filipinos were trained locally and in the United States for the study of fishes and fisheries. H. R. MONTALBAN, CLARO MARTIN, JOSE MONTILLO, and other Filipino members of the staff wrote valuable papers on fishes and fishery methods. Dr. H. A. ROXAS as head of the fish and game administration, and his successor, Dr. D. VILLADOLID, continued the work and from them and their associates such as UMALI, ABLAN, DOMANTAY, AGCO, and MANACOP, and of course those already mentioned, have come many papers.

English, German, Italian, Swedish, American and other naturalists and travelers collected fishes in Sarawak and British North Borneo during the last 80 years. Their material was studied and reported upon by GÜNTHER, VINCIGUERRA, BOULENGER, REGAN, FOWLER, HERRE, and others.

As a result of the work sketchily indicated above, the main features of the fish fauna of the Indo-Australian Archipelago are now known, and the broad outlines of their distribution are distinct. In spite of these facts, intensive collecting anywhere along the coasts of the vast archipelago reveals new and often startling species and genera, while similar collecting in the streams also adds new species to the fauna. In addition, every collection throws new light on the distribution of fishes already known. In the Dutch East Indies there are still great opportunities for one who will emulate BLEEKER in making extensive collections, studying them first in the field and later in the museum. There are still many East Indian fishes unknown to science. This is exemplified every time I make a field trip. The following specially need investigation: — the fresh water fishes of the interior lakes and streams of the larger islands; the gobies, blennies, and other very small fishes of the coral reefs; the fishes of the mangrove and nipa swamps; pelagic fishes; species living below the lowest tide level, out to a depth of about 10 meters; deep sea fishes.

All the preceding is foundation work. Scarcely a beginning has been made in the study of the migrations and seasonal distribution, food, breeding, development and general life history of East

FIGURE 54. — THE LABORATORY FOR MARINE BIOLOGY, NEAR THE PASAR IKAN (figs. 55 & 56) AT BATAVIA.

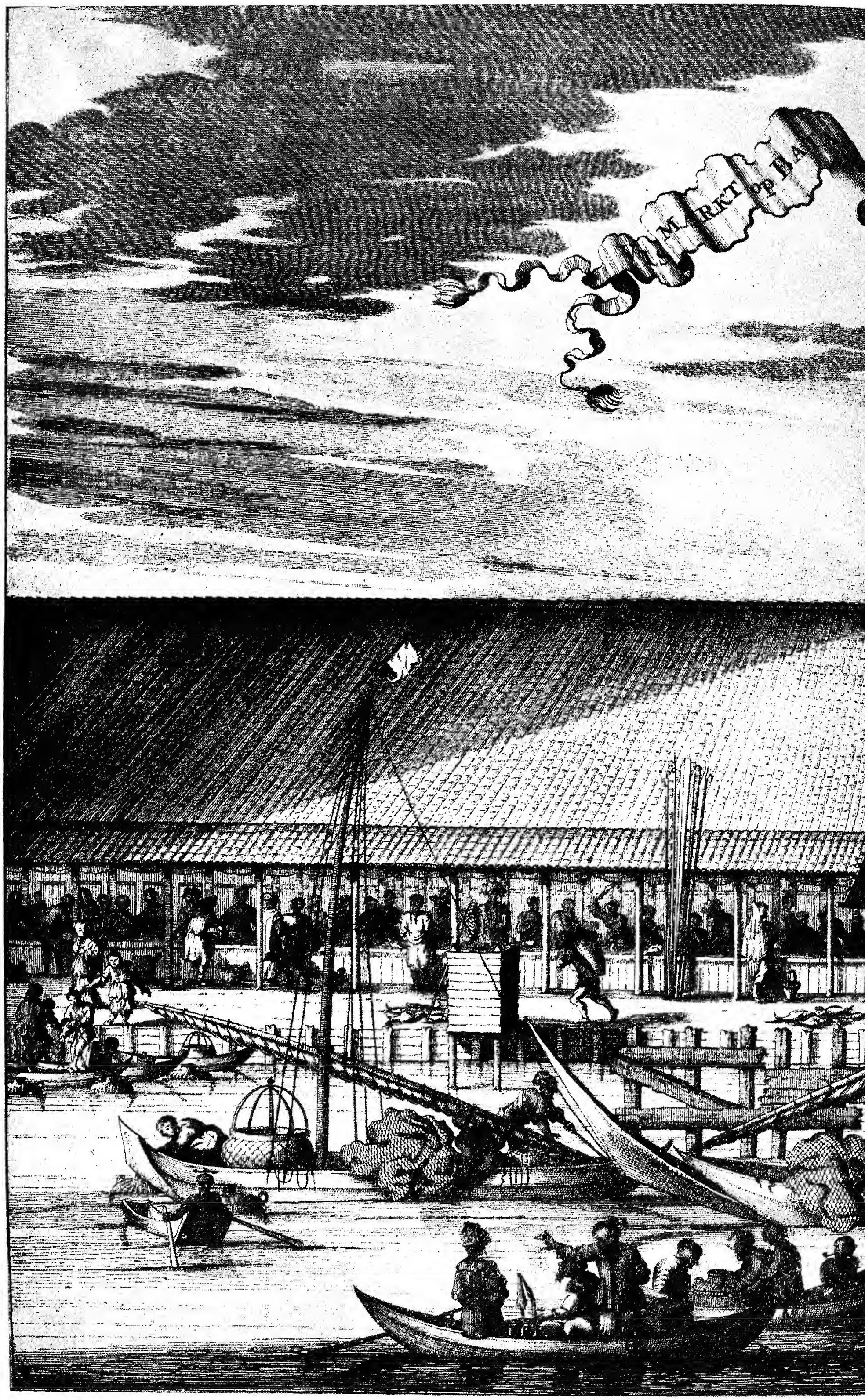
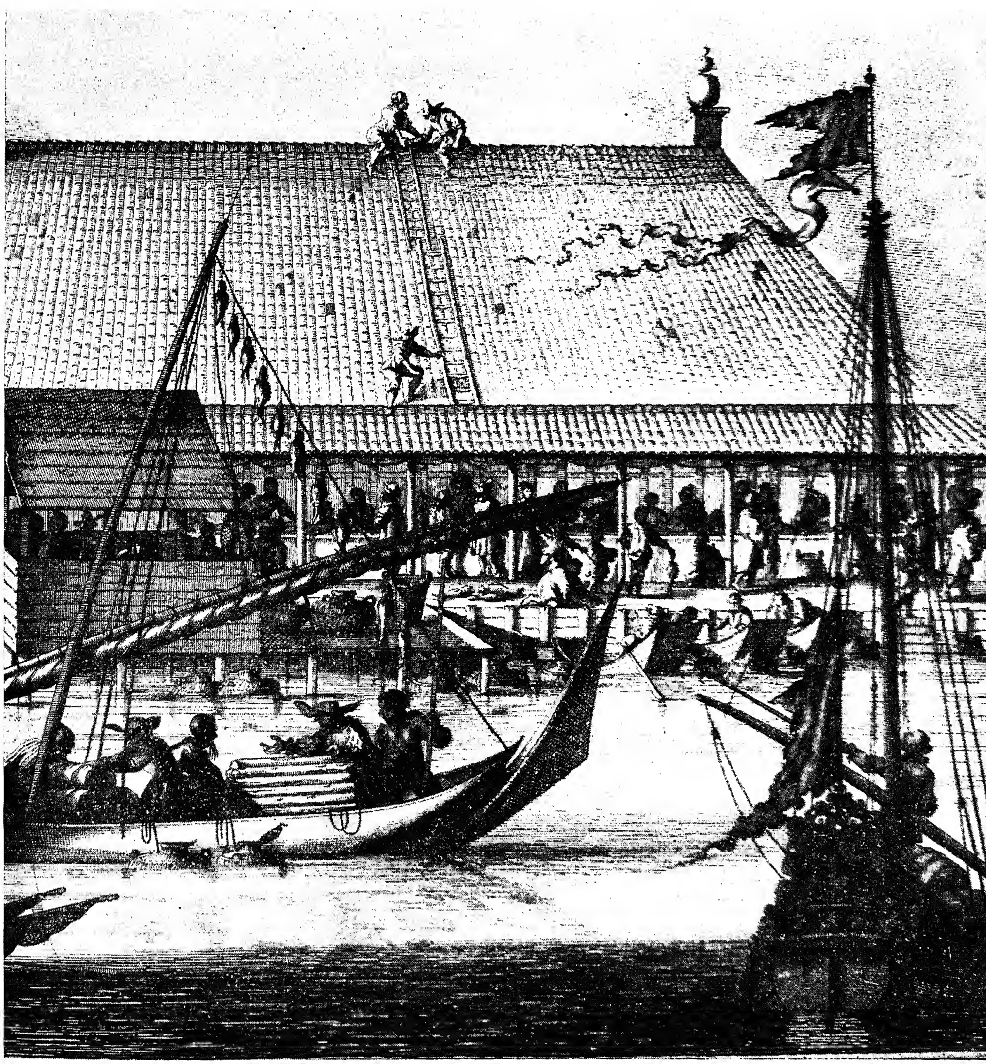



FIGURE 55.—THE PASAR IKAN (Fish Market) AT BATAVIA IN THE SEVENTEENTH CENTURY (*from* JOHAN



NIEUHOF'S "Zee en Lantreize," Amsterdam, 1862. — *Courtesy of the Arnold Arboretum of Harvard University*).

Indian fishes, and work on all these lines is urgently needed. This is especially true of all important food fishes. Aside from the preliminary work done by Dr. DELSMAN and Dr. HARDENBERG in Java, by HERRE and Dr. VILLADOLID and staff in the Philippines, and by W. BIRTWISTLE and staff in Malaya on pond culture, not too much has been done.

When we consider the condition of the fisheries and the insignificant attention paid to their development and modernization, we are confronted by an anomalous situation. All Indonesian people prefer fish to any other animal protein food. Here are not less than 85,000,000 people who do not consider themselves properly fed unless they have plenty of rice and fish. With such a large fish-eating population and seas filled with fish, one would suppose the fishing industry would be highly developed, with an abundance of cheap fish at all times. Such is not the case. The markets are glutted at times, with ruinous returns to the fishermen, but much of the time fish are expensive, the markets poorly supplied with a wretched quality, whether fresh or dried.

The governments of the area have treated the fisheries with neglect or indifference much of the time, and it has been difficult to overcome official inertia, in spite of the fact that fish are a fundamental food of the people. This is the result of many factors, which cannot be considered fully here. A few are, (*a*) the diffused character of the industry, with no great concentrations of capital, especially foreign capital, and no great factories or other establishments for processing. The annual value of Philippine fisheries is not less than $75,000,000 but a large part of the catch never enters the markets, and fish do not bulk large in bank clearings and commercial statistics. The thousands of fishermen and small dealers scattered along all coasts in every kampong and barrio have little or no weight, whereas a concentrated industry doing a business of not more than a fourth of the fisheries commands attention and support from officialdom. Its diffuse character likewise makes it impossible for the industry itself to raise funds, found experiment stations, and improve itself. (*b*) The ignorance of government officials who have the deluded notion that native methods must be all wrong, and whose only idea is to ape European methods without considering their suitability to conditions. Thus very expensive and usually unprofitable experiments with European trawlers have been undertaken in Indonesian waters by Dutch and English officials and American business men. (*c*) The native fishing methods are only for shore fishing, while their boats cannot go out in rough weather, lack deck room and cargo space, and cannot be used for off shore or deep sea fishing. (*d*) The ignorance and poverty of the fishermen.

From time to time governments have started a program of fisheries research, but nowhere in Indonesia has it ever been adequately and continuously supported. To develop the marine fisheries of Indonesia it is necessary for each political division to have, (1) a thoroughly competent staff of scientific and technical investigators, engaged for their productive lifetime, and not for a maximum of 20 years or so, with a constantly shifting and changing personnel; (2) a scientific director with vision, competent to plan and organize programs of investigation in every fishery activity for 5, 10, 25, and more years; (3) vessels equipped for experimental fishing methods of all kinds except the otter trawl; (4) experiment stations for the culture of both marine and fresh water fishes, and the investigation of invertebrate marine resources.

The status of East Indian fisheries and their methods was well described by Dr. H. C. DELSMAN and Dr. J. D. F. HARDENBERG in "De Indische Zeevisschen en Zeevisscherij," (Batavia, 1934). In Dr. HARDENBERG'S paper previously mentioned is given a picture of fisheries investigation in the Netherlands Indies since 1904. The lack of continuity of personnel, with varying degrees of support, most of the time with no vessel available for work at sea, and the small number of investigators at all times, has made progress difficult.

Much the same could be said of Malaya. The director of fisheries, Mr. W. BIRTWISTLE, was the only scientific investigator until 1938, when Mr. D. W. LEMARE was added to the staff. In 1940 Mr. SOONG MIN KONG returned from England, after further training for taking up fresh water fishery problems.

In the Philippines, a competent staff trained in the United States, Japan, and Manila had been gradually organized, and at the time the Japanese struck was under the efficient direction of Dr. D. VILLADOLID. Two large motor launches, equipped for research, were in service, and research on marine and fresh water fishes and fisheries, on crustacea, mollusca, and other aquatic resources was in progress. The culture of gurami, introduced by me in 1927, from Java, had spread to three-fourths of the provinces. It had become a well-established industry, and a new source of food of rapidly increasing importance. The culture of Bangos or bandeng (*Chanos chanos*), in which $50,000,000 was invested in the Philippines, was far more advanced around Manila Bay than in Java or elsewhere. An experiment station for the study of *Chanos* culture alone had been established near Manila, and every effort was being made to replace the traditional rule of thumb practices by scientific methods. Philippine fisheries research, after years of preliminary effort, was at last ready to enter an era of sound development when war came.

In spite of the efforts indicated above, the only real advances made in fisheries throughout Indonesia up until 1940 were those introduced by Japanese fishermen. A few Japanese fishermen, catching shrimps or udang, and *Leiognathidae* (peperek or sap-sap), had been in the islands for many years. In 1919–20 a group of fishermen from the RiuKiu Islands began fishing for the Manila market, using the muro ami method. This method of net fishing, devised for use on reefs in clear water at depths from four to sixteen or eighteen meters, is very efficient and provides large quantities of good fish at reasonable prices. Muro is the Japanese name of species of *Caesio*, a genus of excellent food fishes. The principal fishes taken in quantity by the method are caesios, surgeon fishes, siganids, and balistids. On well stocked reefs a thousand to two thousand kilos will be taken at one operation. The higher priced groupers or sea basses, snappers, porgies, and crevalles or jacks are seldom taken in quantity. The Japanese fishermen, using sea-going motor launches, go in all sorts of weather except during an actual typhoon. From

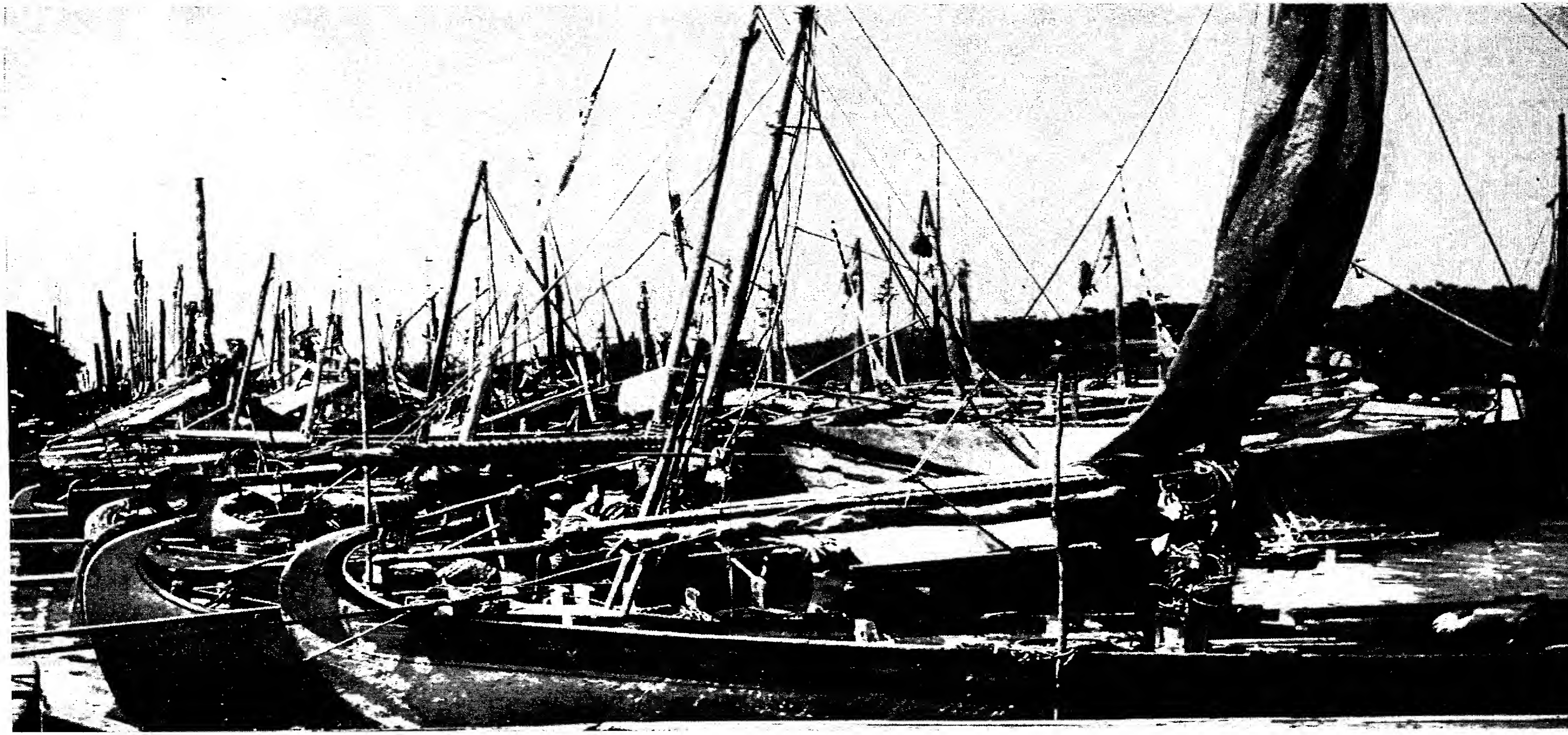


FIGURE 56. — THE PASAR IKAN (BATAVIA), WITH NATIVE FISHING CRAFT, IN THE 20TH CENTURY. — *Courtesy Neth. Information Bureau, New York City.*

fishing grounds near by and from those 700 miles away they brought fish in good condition to Manila. In a short time numerous Japanese outfits were at work over most of the Philippines, and also in the waters of Borneo, Malaya, and throughout the Dutch East Indies. I studied their fishing methods and marketing not only in the Philippines, but also in Malaya and from the Sangir Islands, Celebes, the Moluccas, and Borneo, to Java and Sumatra. Japanese fishermen dominated the fresh fish markets of Manila, Cebu, Singapore, Batavia, Menado, and a great many other cities and towns throughout. Their ability, enterprise, and hard labor supplied a real need and were socially useful. They caught fishes in quantity that the native fishermen seldom obtained and then in limited numbers, and used methods which the natives could not or would not adopt. Japanese boats based at Singapore ranged from the Gulf of Siam and the Andaman Islands to the Moluccas and the Aru Islands, nearly 2500 miles away.

In addition to the muro ami method, Japanese fishermen introduced in recent years the use of large beam trawls, particularly in the Philippines, the South China Sea, off the west end of Sumatra, and in the Bay of Bengal. Long line fishing and hook and line fishing for tuna and bonito were also introduced, particularly in the Gulf of Davao, the Celebes Sea, and the Sulu Sea. They opened a tuna cannery at Si Amil, near Tawao on the east coast of British North Borneo, in 1928, and one at Zamboanga about 10 years later.

For many years Japanese experimental fishery vessels, directed by competent scientists and manned by large crews of well trained fishermen, made prolonged voyages throughout the Indonesian island world. Special attention was paid to the migrations and feeding grounds of pelagic fishes, particularly the tuna family, and to discovering new fishing banks and the best methods of fishing them. As a result, Japanese have had more knowledge of the fishery resources of the entire Indo-Australian archipelago than the officials and scientific men of those countries could obtain, handicapped as the latter were by the lack of such vessels as the Japanese used so freely.

When peace returns to Insulinde, we may reasonably expect that Japanese fishermen will no longer be a factor in island economics. Industries in general will be disorganized, and fishing will be no exception. The great city markets will not receive supplies from remote fishing grounds, and the more desirable fish will be at a premium. The various governments, Dutch, British, Filipino, should have their attention directed to the importance of adequately feeding the people by a better development of the fisheries. One of the steps necessary will be the training of native fishermen to use motor boats and to adopt modern methods. Only thus can be filled the gap left by the withdrawal of Japanese fishermen. Sixty years ago Japanese fisheries were but little better than those of Malaya, and the fishermen were using methods unchanged for centuries. All this was changed and Japan became foremost in fisheries, a result largely due to a new system of education. Schools for fishermen's sons were established in every fishing village, where boys were taught about boats, better nets and tackle, and improved methods of catching fish. In each prefect a high school was established where advanced work was taught, navigation was studied, and graduates were fitted to be captains of vessels, and master fishermen. Finally a fisheries institute, a part of the university of Tokyo, was founded. Here scientific leaders, technical experts, administrators, and all sorts of teachers for fisheries matters were trained. No other country has such a well integrated system for educating fishermen and all sorts of people for every conceivable matter connected with fishes and fisheries. Particularly in the Netherlands Indies and in the Philippines there is urgent need of establishing some sort of school system for educating fishermen's sons, as soon as governmental control is wrested from the Japanese. This matter cannot be left to chance, and the methods of kampong and barrio. The welfare of too many millions of people is at stake. The ancient Malayan methods for inshore fishing are excellent, in the main. But there is need for utilizing the vast resources of off-shore waters. Not only could the people be adequately fed thereby, but a surplus could be processed for export.

There is an impression, based upon inadequate knowledge and lack of extended field experience, that Indonesian waters are poorer in fish than more northern waters. Chemical analysis of sea water, and limited collections of plankton have been held to prove that there are few fish in tropical waters. The astounding amounts of plankton that occur at times, when planctonic organisms increase to such a vast extent as to destroy most other forms of life, and the frequent recurrence of such phenomena, seem to have totally escaped the observation of those who say tropical waters are poor in fish. When one sees vast schools of sardines, as much at times as ten miles in length, shoals of mackerel, certain species of carangidae, schools of tuna and bonito miles long, and other fishes in enormous numbers, he knows that such ideas are erroneous. Porpoises are large mammals that live on fish; I have seen a school of porpoise that was 15 miles or more in length and one to two miles wide. Just visualize the quantity of fish such a school consumes daily.

The fishes just mentioned are migratory and more or less pelagic, only coming along shore occasionally. They pay no attention to man's political boundaries, which usually flout the laws of nature. In order to properly develop the fisheries and ensure their perpetuity, there should be an international commission to study the migratory schooling fishes, with power to control their catch for the market. The commission should be empowered to use all means necessary to study the complete life history of such fishes, irrespective of political boundaries. When sufficient information was obtained, international regulations could be devised to ensure the perpetuity of the fishery. For such a commission we have as examples the very successful commissions already in existence, both in Europe and in the North Pacific between Canada and the United States. In 1929 I presented a plan for this purpose at the Fourth Pan Pacific Science Congress, held at Batavia, under the title "The Scientific and Commercial Development of East Indian Aquatic Resources."

Under Japanese control, the commerce and most industries of Indonesia rapidly became disorganized, or perished entirely. To-day in many regions the people are hard pressed for food. Many have left the cities and returned to their ancestral barrio or kampong, where they have some

chance of growing a little food and catching a few fish or crabs or shrimp, or eating mollusks.

When the Japanese are driven out, commerce will be dead and industrial life at a low ebb. While the military are active, cities will be artificially stimulated, but with the withdrawal of armed forces the people will have little in the way of trade and should be helped to establish means for obtaining and distributing food. This will be especially true of fish, their main protein food. The native fishermen cannot be expected to supply an adequate amount of fish to the cities and towns, or to the plantations. The price of this essential food will soar, while the quality of both fresh and dried fish will probably be far below the pre-war quality.

The proper steps should therefore be taken to train young men as fishermen, with emphasis upon the adoption of improved methods. The ancient Malayan methods should not be discarded blindly, and the traditional skills and knowledge of tides and currents, of reefs and fishing banks, of migrations and habits, should all be preserved. But the use of motor boats, beam trawls, improved nets and other fishing gear, and the use of ice and freezing methods, should be carefully taught. Such boats and gear should be used to supplement the existing native methods, and to utilize fishes not caught by the old Malay methods. To train young men in the ways indicated is far more urgently needed than to train clerks or lawyers or salesmen. It will be necessary to make loans for the purchase of boats and gear, and to maintain young men while they are being trained, as the fishermen will have no capital. But the people must be properly fed if they are to be healthful, industrious, and contented. Money spent to improve their food resources, and to help them provide themselves with more and better food, will be wisely spent.

To make the necessary scientific investigations and to train properly an adequate native staff, it will be necessary to apply some of the methods found so successful by the Japanese.

If the governments fail to do anything about the development of fisheries on a sound scientific basis, we may expect to see Japanese fishermen return to Indonesian waters in another generation. We cannot expect to fail in supplying an economic need, and expect to keep out those who will labor to supply the demand.

# AGRICULTURE IN THE NETHERLANDS INDIES

*by*

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*The Hollanders, who are certainly the most industrious People in the World, make it a great Part of their Business to collect Plants from all Parts of the World, in order to chuse out those which may be useful to them, either at Home or in their Indian Plantations, and the States there, give great Encouragement to such as do their best Endeavour in this Way; for that Nation finds its Advantage by so doing* ... (BRADLEY, Gen. Treat. Husb. 3, 2:65, 1724).

In the Netherlands Indies, two kinds of agriculture are very important to national economy: that concerned with supplying the native population with enough nutritious plant foods, and that concerned with the cultivation of export products like tea, sugar, rubber, cassava, tobacco, coffee, copra, and cinchona. These products are considered staples; that is, they are fairly uniform in composition and quality, and are like those of other countries in nature and methods of delivery.

The agriculture most important to the population is that which raises food. It has been the government's deliberate policy to give preference to the production of necessary foods rather than to the cultivation of export products. For example: the law stipulates that not more than one-third of the tillable surface of a village community may be planted with sugar cane; furthermore, sugar may be cultivated only as a rotation crop in order to maintain the productivity of the soil and to ensure fertility by regular tillage.

Export agriculture or, as it is also called, European agriculture, was started in regions where uncleared land was abundant; labor imported from other parts turned the jungle into cultivated lands supplying products required in the world household.

Besides this agricultural development of the last 70 years there was, at the beginning of the last century, a system which aimed at increasing the income of the Netherlands Indies by legally compelling certain districts to produce certain quantities of export products. After this so-called "cultivation system" had been applied for several decades, it was abandoned because the politically liberal period of the past century was wary of compulsory deliveries and government interference in the process of production. It was feared that this could lead to excesses and was contrary to the principles according to which a community should be developed. At that time the government was considered the guardian of justice, who was not to interfere with the actual production process, but should see that certain legal principles were adhered to in relations between people, emphasizing the freedom of industry and agriculture to develop these relations economically as they judged best.

The Cultivation System doubtless gave rise to the important sugar cultivation and the extensive cultivation of coffee in the Netherlands Indies. Other products received their first stimulus in other ways.

The beginning of the great development of Netherlands Indies export agriculture dates back to the period from 1880 to 1900. They were undertaken by concerns that rented sites from the population or were granted government concessions to open up waste land for a certain crop for a period of 75 years, in return for a fixed compensation and other obligations agreed on with the government.

In this way a large number of agricultural plantations came into existence. The extent of

* Substance of an address to the Botanical Society of Washington, D.C.

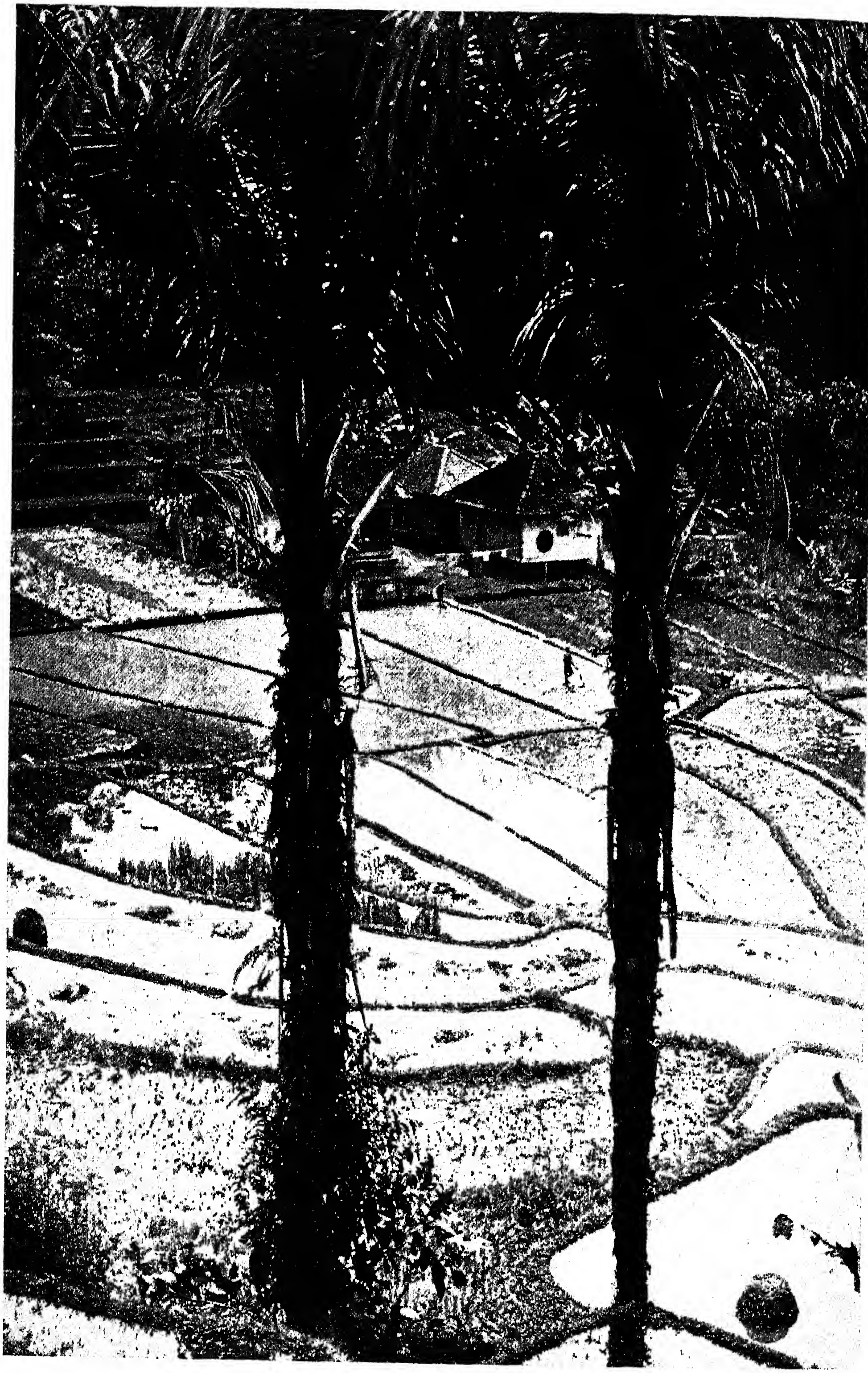

FIGURE 57. — RICE FIELDS IN THE PREANGER (WEST JAVA). — *Courtesy Netherlands Information Bureau, New York City.*

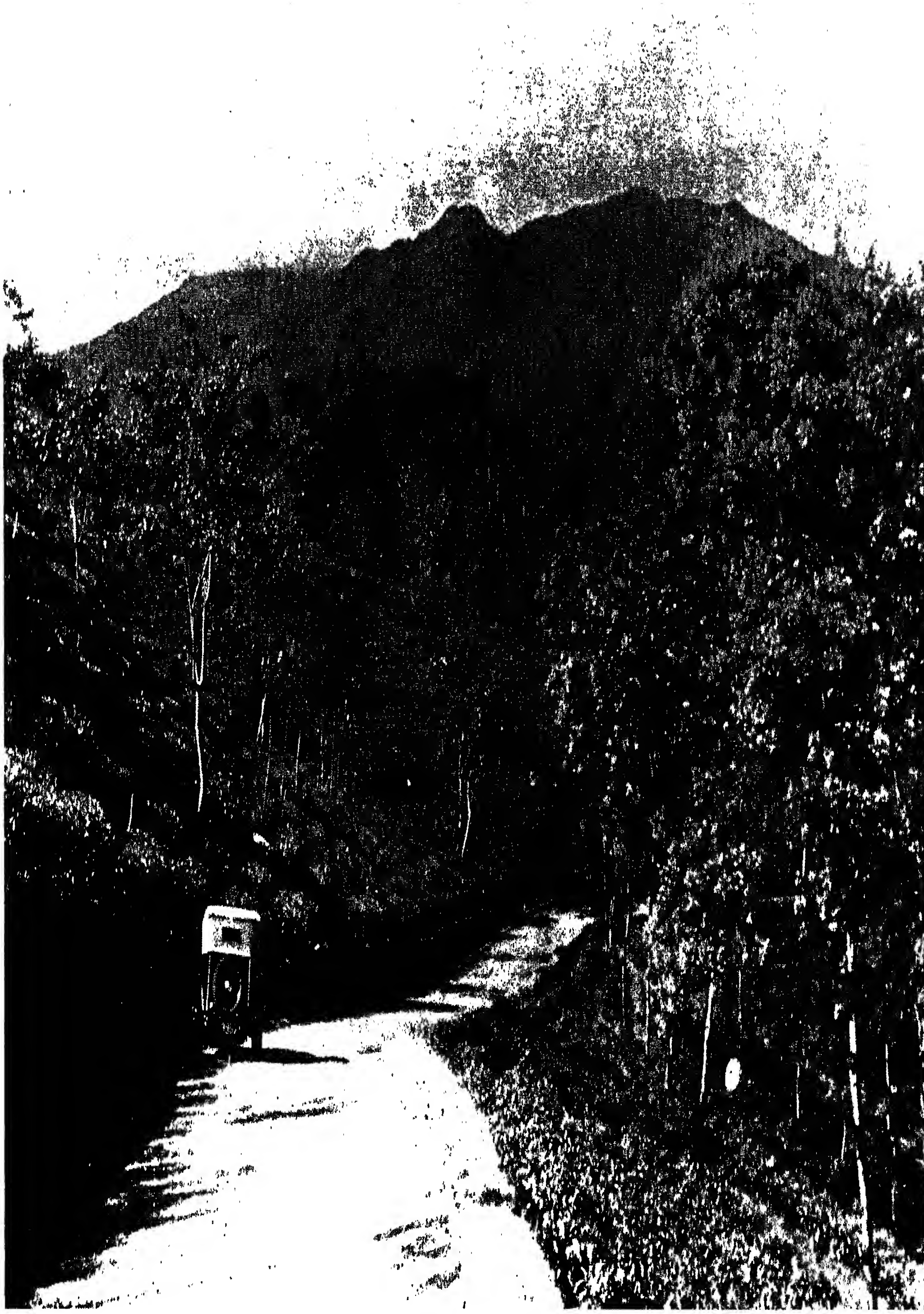

FIGURE 58. — A TEA PLANTATION IN JAVA. — *Courtesy Netherlands Information Bureau, New York City.*


FIGURE 59. — THE EXPERIMENTAL GARDENS OF THE GOVT. BOTANIC GARDENS IN BUITENZORG IN 1892. For a list of the plants grown at that time see M. TREUB 1892, "'s Lands Plantentuin te Buitenzorg, 1817-1892" (Batavia: Landsdrukkerij), pp. 487-503.

This garden was established in 1876. It has developed greatly in the course of the years. In recent years the "Cultuurtuin" issued an annual list of seeds, cuttings, etc. which were made available by the Dept. of Agriculture to individual growers. A recent list is divided into the following sections: 1, *Hevea;* 2, *Ceiba pentandra;* 3, *Piper;* 4, *Theobroma;* 5, *Cocos;* 6, *Elaeis guineensis;* 7, *Eugenia;* 8, *Vanilla;* 9, *Andropogon;* 10, *Derris;* 11, Shade trees, etc.; 12, Various leguminous plants (especially for greenmanuring).

The "Cultuurtuin" had trained a number of government gardeners (especially in grafting). The services of these gardeners, being available at a nominal charge, were much in demand.

their main export crops can be seen from the following table:

IMPORTANT EXPORT CROPS IN THE NETHERLANDS INDIES IN 1939

| *Crop* | *Area planted in 1000 ha.*[1] | *Number of plantations* | *Production in 1000 kgs.* |
|---|---|---|---|
| Sugar | 94.9 | 100 | 1562.462 |
| Hevea Rubber | 615.6 | 1199 | 198.087 |
| Coffee | 99.2 | 377 | 58.319 |
| Tea | 138.4 | 337 | 83.159 |
| Tobacco | 36.5 | 89 | 39.003 |
| Cinchona | 17.0 | 110 | 12.391 |
| Cocoa | — | 37 | 1.738 |
| Palm Oil prod. | 105.0 | 66 | 297.449 |

Total planted area in hectares on plantations in the Netherlands East Indies in 1939:

| | |
|---|---|
| Java and Madoera | 607.468 |
| Outer Provinces | 597.767 |
| Total | 1.205.235 |

Many Netherlands East Indian products — rubber, for instance — are produced by native growers as well as by plantation owners. The export figures in the preceding table refer only to plantation production. Some products, such as sugar and cinchona bark, are grown exclusively on plantations.

In the cultivation of cinchona, government agricultural establishments have played a special part which is of particular interest to us in this survey. Cinchona was originally developed by the Netherlands Indies government, at a time when the government still participated in cultivation. Moreover, the prospects of this cultivation were so uncertain that private initiative could not be expected to take up this branch of agriculture.

The Netherlands Indies government considered the cinchona cultivation necessary to obtain the cinchona bark which had been recognized as very valuable in combating malaria, a common disease that disastrously affects the well-being and energy of the population in many parts of the archipelago.

The government has continued its cinchona cultivation to the present day. It later developed a system similar to that of the private estates. The structure of the business is commercial; but according to a unique practice, results obtained on these plantations benefit the whole community and progress made on these plantations is not restricted thereto but made available to the entire cinchona industry in the Netherlands Indies.

***

To understand the development of agriculture in the Netherlands Indies one must know the landed property situation. The main principle is that the land in the Netherlands Indies remains the inalienable property of the autochthon population. Foreigners in the Indies, even those who, though born in the Indies, cannot be reckoned as belonging to the autochthon population, cannot own landed property.

Uncleared lands, the so-called waste lands, are considered crown lands, the right of disposal of which is in the hands of the government, either by settling these regions or throwing them open to cultivation. For this, concessions are granted, which are generally to last for 75 years. They give the right of occupation, but provide that at the end of 75 years, the lands concerned are given back, without right to compensation, to the government, which can then decide, according to local circumstances, whether to place these lands at the disposal of the people because this step is necessitated by the increase of the population, or to use them for purposes of irrigation, or afforestation, in order that satisfactory food supplies may be provided by native agriculture.

In the Netherlands Indies, the variations in average temperatures and rainfall have created widely divergent agricultural conditions. In the mountains there are cooler climates and, in certain parts of the Indies, a very heavy rainfall, so that cultivations with very different demands on climate and soil can be successfully operated side by side. In regions with high rainfall and a relatively low average temperature for the tropics, one finds plantations of tea and cinchona next to each other.

Where there is a more pronounced dry season, coffee is cultivated. In the warm districts on the plains there are tobacco, sugar, and cassava. In regions with a relatively low rainfall restricted to the so-called wet monsoon, one finds copra and spices. Rubber is cultivated in localities with relatively poor soil and constant rainfall or pronounced monsoons.

***

Since the middle of the past century, the Netherlands Indies plantations have benefited greatly from the results of scientific investigations. For this purpose experiment stations have been established on a coöperative basis generally without any compulsion or interference by the government and each usually devoted to a single crop. In this way, experiment stations have been established for sugar, tobacco, indigo, coffee, tea, rubber, and cinchona. In recent years they have been extended to include palm oil and roselle fibre. In addition, there are other organisations called "Centers" which collaborate in furthering the cultivation and standardization of kapok, essential oils, tapioca, and gums and resins.

Until 1932 the distinctive feature of the experiment stations in the Netherlands Indies was an absolutely free exchange of experiences and an unlimited right on the part of the research workers to publish their experiences and to compare their views with those of their colleagues anywhere else in the world. The conviction that the system of free trade, of which the Netherlands Indies has been a keen advocate, was the best for the country brought with it the obligation to see that the liberty to exchange goods was accompanied by the liberty to exchange experiences and views. It was hoped that in this way world markets could be supplied with goods produced in those places where they could be developed most efficiently, that is, most cheaply or, in other words, with the least effort and the greatest quantity per surface unit.

The free exchange of experience is a complement to the free exchange of goods. In this way the supply of goods will be secured most efficiently in definitely designated production areas. This reciprocity can be developed or maintained only when production methods are made known and when it is recognized that the natural right

[1] 1 hectare = 2.471 acres.

of every country and every production region is to develop the crops that it can operate better than other production centers.

The year 1932 brought a marked change in this conception. At that time the world turned selfishly despotic in all respects. Domestic products were protected by tariff walls and import quotas. Every country tried to protect its own production with all the means at its disposal, including restrictions of the exchange of experience.

It is not necessary here to enlarge on the recent past. The development of our agricultural enterprise was a result of freedom. It is inevitable that the tendency toward secrecy becomes a two-edged sword which turns against national production. It leads to secrecy within a small circle and to the neglect of possible developments because there is no free discussion of the ways open for such development. This condition leads to a working situation in which orders come from a central point and travel along organized ways. Collaborators are deprived of the pleasure which grows from understanding and sharing what happens, from the knowledge of the how and why of proposed changes, and from the recognition of results and their application in the practice of the organization.

If there is something to be learned from Netherlands Indies agriculture, it is the understanding that development is closely connected with a free exchange of experience and the recognition that great value accrues from every collaborator being given an opportunity to announce his views, to have these tested by experiments, and to speak of his own experiences at meetings and in trade literature. This condition of cooperation permits all to collaborate and to understand proposed projects. It fully recognizes the enormous value of workers who are earnestly and energetically pursuing science. They show by their own example that the collaboration of all concerned is an essential condition of progress. With this cooperation between the specialist and the nation real progress is possible. Together they are enthusiastic for the new things that can be created; together they are enthusiastically convinced that every personal work is of value to the work of the entire community.

If in our time, when there is so much talk about the ideals of freedom, a lesson can be learned from the past, it is that Netherlands Indies agriculture shows how collaboration in freedom — practically unhampered by contractual regulations to one's own company, to the chief or other superior, or by other ties, but borne on the idea that the work which one has to do has the highest priority when determining one's actions — leads to pre-eminent achievements. It shows one way to raise our world to a higher plane, one way to realize the ideal of freedom from want: supply efficiently the available goods to all who are in real need of the necessities of life.

In the above account only a few very important crops have been mentioned. It has been said by Dr. E. D. MERRILL that more useful plants are known from the Netherlands Indies than from any other territory of comparable size. A full account of these plants has been given by K. HEYNE (1927) in his "De Nuttige Planten van Nederlandsch-Indië", ed. 2, 3 vols. (Batavia). — An extensive account of plantation (export) agriculture will be found in K. W. VAN GORKOM'S "Oost Indische Cultures", ed. 2, 3 vols. (Amsterdam, 1913).

# Chapters in the History of Cinchona

## I, A SHORT INTRODUCTORY REVIEW

*by*

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The history of cinchona cultivation in Java is another instance of the successive ups and downs which characterize the development of economically important products. In this respect, cinchona is analogous to sugar, coffee, tea, and rubber-yielding plants. In the period just ended we were able to speak of profitable, well-organized cultivations of a few plants developed under stable and praiseworthy work-relations throughout; at other times, there have been decline and depression.

In those latter cases, planters had to find the courage to persevere despite reverses, for history shows that a period of failure is usually followed by one of success. On the other hand, a period of success in any branch of agriculture — especially in tropical agriculture — must never be considered permanent. The state of production in other countries, economic conditions abroad, and particularly the imperfect application of newly acquired insight at other centers, added to the flagging of one's own efforts, can easily turn that which is today called prosperity into an alarming, precarious state of depression.

Cinchona cultivation in the Netherlands Indies began in 1829 when BLUME, the director of the Botanical Gardens at Buitenzorg, proposed that the Netherlands Indian government bring the cinchona plant to Java. Many agricultural experts, familiar with conditions in Java, supported this proposal. The land had been made available under the provisions of the contracts with the government, concluded in 1837, wherein waste lands were to be used to grow cinchona.

The first cinchona plants to be brought to Java were carefully grown by MIQUEL in the hothouses of the Botanical Gardens at Leiden. In December 1851, the first specimen of *Cinchona calisaya* was shipped from the Netherlands to Java; it survived the voyage and transplanting, thanks to the good care of TEYSMANN, the famous horticulturist of the Botanical Gardens at Buitenzorg.

Many other experiments followed. The detailed history of cinchona cultivation in the Netherlands Indies is found in official reports of the Agricultural Service ("Officieele Landbouwkundige Verslagen") and in the accounts in the *Java Courant* of the development of cinchona in Java from 1856 to the beginning of the twentieth century.

HASSKARL was the first man to import cinchona directly from South America. The story is told in a brochure entitled *The Cinchona Tree Brought from South America to Java by Order of his Majesty and King, William III* ("De kinaboom uit Zuid-Amerika, overgebracht naar Java op last van Zijne Majesteit en Konig Willem III") by DE VRIEZE (The Hague, 1855). The record of this pioneering effort, with all its attendant difficulties, is one to inspire a novelist to write of the stirring stories about the transportation of cultivated plants.

HASSKARL left the Hague for South America on December 14, 1852, and arrived in Batavia on December 13, 1854, bringing with him eighty plants which had remained alive. Some of the plants and seeds collected in South America were shipped to the Netherlands and, after being raised there, were brought to Java.

Thus began the first period of practical cinchona cultivation. It lasted from April 1852 to June 1856. During that time the first specimens of cinchona were received from the Botanical Gardens in Leiden; HASSKARL brought plants and seeds from South America; the first nursery gardens were laid out at Tjibodas in Java early in 1856 when more than forty-two specimens of *Cinchona calisaya* and sixty-four specimens of *Cinchona ovata*, both grown from seed, and two hundred thirty-eight specimens of *Cinchona calisaya* and fifty of *Cinchona ovata*, both grown from cuttings, were planted.

The second period lasted from June 1856 to March 1864, when JUNGHUHN, the great organizer and meritorious naturalist, was made director of cinchona cultivation. During this period, the center of cinchona cultivation was transferred to Tjijiroean, where the government had established its first cinchona plantation. Tjijiroean is still the center of cinchona cultivation. It is a place where men of great scientific merit have worked, their efforts and insight enabling cinchona cultivation

in the Netherlands Indies to rise to the heights it reached in the nineteenth century.

As early as 1858 a second cinchona plantation was established at Tjibeurem.

JUNGHUHN wrote the first manual about cinchona cultivation. It appeared in 1859 under the title *Provisional Guide to Experimental Cinchona Cultivation* ("Voorloopige handleiding van de proefkinacultuur"). It shows how, in the course of the years, fundamental changes were introduced in the technique of cultivation (*cf.* p. 192.)

A careful analysis of other publications which have appeared in the course of time shows how systematic investigation made this gradual development possible.

A very important fact to note is that, shortly after the beginning of this cultivation, the collaboration of conscientious naturalists, chemists, and biologists was sought and procured, and that efforts have been made to build this industry on strictly scientific lines.

The third period of cinchona cultivation extended from March 1864 to 1873, when its direction passed from JUNGHUHN to Dr. K. W. VAN GORKOM. During this time the chemical composition of the alkaloid content of the bark was systematically investigated, trees were selected because of this alkaloid content, the great value of *Cinchona Ledgeriana* was recognized, less productive cinchona varieties were eliminated, good botanical descriptions of the varieties being cultivated were compiled, and the variability of the alkaloid content of *Cinchona Ledgeriana* was recognized. This last work was stimulated primarily by the studies of J. C. BERNELOT MOENS, who was employed as chemist for the cinchona cultivation on March 22, 1872. This third period concluded the organization work of VAN GORKUM, who wrote about his experiences in three publications: *Contribution to the Knowledge of the Cinchona Cultivation* ("Bijdrage tot de kennis der kinacultuur"), 1868; *Memorandum concerning the Treatment of Cinchona Plants* ("Nota betreffende behandeling der kinaplanten"), 1869; and *Outline of a Guide to the Cinchona Cultivation* ("Schets eener handleiding voor de kinacultuur"), 1870.

The fourth period, that ended with the opening of the twentieth century, began with BERNELOT MOENS as director of cinchona cultivation. Under BERNELOT MOENS *Cinchona Ledgeriana* was grown more extensively, and the use of *Cinchona succirubra* as a stock was introduced, with the result that, in a very short time there were many cinchona estates in the Indies, some belonging to the government, and some to private individuals. A unique principle adhered to at this time was that all discoveries made on the government plantations be available to the entire community, that plant material and seed be distributed without restrictions to all estates interested in cinchona cultivation.

During this period the scientific work was extended. The services of the chemist VAN LEERSUM and the botanist-physiologist J. P. LOTSY were secured. By 1900 the foundations of the present Netherlands Indian cinchona cultivation had been laid. Full publicity had consistently been given the manner of working and the line of thought regarding the possibilities of development that could result from diligent work and favorable cultivation conditions. Because of the scientific spirit and the free exchange of thought among all those connected with this cultivation, there developed a technique of culture that has never been excelled. It cannot be denied that cinchona cultivation has grown up in the Netherlands Indies without subsidies, and without any attempt to eliminate or impede its development in other countries. On the contrary, complete readiness to inform other countries of the work done, and to make plant material available without reserve wherever it was needed has always been shown. It is important to recognize this altruistic side of the cinchona cultivation in the Netherlands Indies and particularly in Java, and to see in it an example of the spirit of enterprise supported by initiative and perseverance and carried on in a truly scientific way.

# Chapters in the History of Cinchona

## II, THE INTRODUCTION OF CINCHONA INTO JAVA

*by*

K. W. VAN GORKOM (1835–1910), Dr. pharm. hon. c.*

*late Inspector, Govt. Cinchona Plantations, Java; late Chief Inspector for Sugar and Rice, Dept. of Agriculture, Buitenzorg; Editor "Oost-Indische Cultures"; etc.*

In our historical summary, the instigation towards undertaking trials for acclimatizing the *Cinchona* plant, was sufficiently set forth. At the instance and by help of WEDDELL, the French government took the initiative in Algeria. At the beginning it appeared as if good results might be looked for; but either the choice of situation was not fortunate, or else the officials were insufficiently acquainted with the needs of the foreign nurslings, so that they were not placed under the most favourable conditions; the experimental planting, therefore, soon went entirely to the bad; according to the official reports they were annihilated by the sirocco.

The English government was no more fortunate in its first attempts, and it was generally thought that the Netherlands in its rich and extensive colonies, possessed the best opportunity with regard to satisfactory results, to venture on a new and earnest experiment. Indeed, the question of a lasting supply from the mother-country of *Cinchona*, having regard to the uncontrolled exploitation in South America, had taken an international character, in which all civilised peoples may be said to be concerned.

In the Netherlands, the full weight of this consideration was also felt. A first attempt towards

* Reprinted from the author's "A Handbook of Cinchona Culture," translated by B. D. JACKSON (Amsterdam & London, 1883, pp. 38–62).

bringing over the *Cinchona* to Java, was made in 1829 by BLUME. During the years from 1830 to 1837 the subject was considered also by KORTHALS, REINWARDT, FRITZE and JUNGHUHN; meanwhile with but little good result.

The government was quite convinced of the desirability of earnest efforts being made, but the conditions of the time could not be called favourable for the prosecution of a task which would doubtless demand considerable pecuniary sacrifices, and of which the results and eventual fruit could not be anticipated.

It is a noteworthy fact, that, when the Director of Cultures in Java, HEER DE VOGEL, in 1837 drafted model-contracts for issue in hiring waste lands, he was already thinking of the possibility of a special exploitation by private means for *Cinchona* culture.

But the time for vigorous measure had not yet arrived; men however like VROLIK, MULDER, DE VRIESE, and MIQUEL were not weary of calling the attention of the government to the subject and keeping it awake, and it may be added that finally the travels and writings of WEDDELL, gave an impetus towards a decision which could no longer be restrained, after his increasingly weighty argument, of the real urgency of the case and his exact information given about the ways and means towards succeeding in the quest.

It was reserved for the Minister for the Colonies, CH. F. PAHUD, to undertake and carry out the necessary arrangements for the great work. In the year 1851 PAHUD communicated his plans to F. JUNGHUHN, at that time sojourning in the Netherlands, and already famous as an Indian naturalist. These plans were on an ample scale, and of wide comprehension.

The government wished to send an expert to South America, there to collect seeds and plants and bring them over to Java. JUNGHUHN was chosen for this difficult but honourable task, and it was expected of him, that he would eagerly seize the opportunity to attain to a thorough knowledge of the country, which had become famous by the classical writings of A. VON HUMBOLDT and many others. JUNGHUHN applied himself assiduously to study all the existing writings and official information, which would conduce to his preparation for this highly important mission, and the satisfactory issue of the subject.

Meantime, the project came to nothing. As JUNGHUHN testified some years later in his reports, he gave up his commission, and the distinction of the mandate, on behalf of his old friend, J. K. HASSKARL, who had been the colonial botanist during the years 1837 to 1843, and in 1846 was engaged at the state botanical garden at Buitenzorg in Java, but afterwards having been removed from his proper sphere, was at that time in Dusseldorf employed in business, still ardently longing to be replaced in active service, which would satisfy his scientific knowledge and love of Nature.

What followed need not be detailed. The fact is, that the Dutch government forced the difficult mission on Dr. HASSKARL, whose doings and actions we must now briefly recount.

Difficulties and dangers of all kinds were involved in the commission, for cooperation on the part of the South Americans could hardly be reckoned on. It might rather be expected that every step, and every action which might seem to threaten the maintenance of their monopoly would be resisted, whilst in the distracted political condition of the South American Republics, any foreigner appearing to cherish the design of attacking the most notable and richest source of livelihood, had very little guarantee of his personal safety.[1]

Thus the commission required the utmost delicacy of management. Confidence was reposed in a scientific man, who possessed besides courage and hardihood, a strong constitution, experience and hearty devotion.

HASSKARL was sufficiently prepared and ready to start, when a circumstance happened which did not make his task seem easier, and moreover compelled him to be very careful. An interested but somewhat clumsy publicist, unseasonably disclosed the plans of the Dutch government abroad, and it was reasonable to expect that this would be reported to South America, where the inhabitants thus enlightened, would certainly do their best to counteract and frustrate all attempts. HASSKARL'S papers were drawn up and made ready, with an eye to these facts and considerations.

The intrepid explorer left Europe in December 1852, as Herr MÜLLER, native of Cassel, living at Amsterdam. Having arrived in the West Indies, he thence travelled over the Isthmus of Panama to Callao, which port after numerous difficulties and perils was reached on the 31st January 1853.

In the West Indies and at Panama yellow fever was then raging, consequently quarantine was observed in the splendid bay of Callao.

A surgeon came on board to inspect the crew and passengers. He did ample justice to the abundant table of the steamship, and probably it was to be ascribed to this, that he did not notice the symptoms of the dreaded disease, which according to everyone else, were plainly to be recognised in one of the passengers; the official doctor saw no danger, and declared everything in order. The quarantine was raised, the passengers disembarked, and the following day, Callao for the first time became acquainted with the terrible yellow fever. The passenger died; Callao was infected.

Herr MÜLLER hastened to leave the place, and turned immediately eastward towards Lima, the ancient royal city, the Paris of South America. Various circumstances here compelled him to a stay of three months, which he turned to profit in acquiring the language of the country, and opening up good connections.

Just at this time, the Peruvian government had the idea of peopling the eastern districts of its territory with European colonists. The distant uncultivated wastes were still for the most part unknown.

Our traveller made good use of this circumstance. He had pretended to travel with a scientific aim, and now agreed to give his best experience and observations, provided the government assured him of its moral support.

Thus it fell out; recommendations were sent to officials and the clergy in the interior; the gov-

[1] It appears quite true, by reports just to hand from the heart of the *Cinchona* countries, that the South Americans are still out of humour at the disturbance of their monopoly. At the present time however it is easy to collect seeds of *Cinchona* there, although the illusion of thereby getting possession of the better sorts must not be entertained. On the contrary, there prevails a resolute intention, to further the propagation of inferior descriptions outside their own country.

ernment therein expressed its desire that all things required by the traveller MÜLLER, should be furnished, and indeed, he thus obtained the best opportunity to procure the necessary knowledge and data.

For more than a year HASSKARL roamed about the Andes, sometimes penetrating to a height of 15,000 feet above the sea.[2]

From every point of view, and in ample measure he experienced difficulties, incidental to a waste, unknown, and very primitive or uncivilised country. There was no lack of dangerous, and sometimes droll adventures; with all that even in the midst of the *Cinchona* forests, it seemed still difficult to collect seeds and plants. Now and then, it cost much toil and tact, to dispel arising distrust or to adroitly divert it, and once in that position, there was no end to obstructions and impositions.

Nevertheless he succeeded in getting possession of some seeds, and sent them by trusty hands direct to the Netherlands, and after the turn of the year, several hundreds of young plants were collected, which safely reached the coast, packed in twenty one cases. By a concurrence of accidents, some others dispatched in advance, were injured by neglect at Panama.

At the end of August 1854 HASSKARL was able to embark at Callao with his costly treasures on board the Prins Frederik Hendrik, a war ship sent from the Indies. A heavy task was accomplished, but the series of cares and disappointments was not closed with it.

Sailing in a westerly direction in the Pacific Ocean, they arrived at Makassar, where the war steamer Gedeh took over the charge, and brought it to Batavia on the 13th December 1854.

The concern now was to forward the young plants to the cool mountains as speedily as possible. During the long voyage they had suffered much, so that not more than seventy reached Tjibodas on the Gédé range of mountains, an establishment to be described presently.

HASSKARL's mission may be said to have been completed with credit and satisfaction, and the Dutch government gave him substantial proofs of recognition and estimation. Certainly to no one better than to him, could the further care of the new colonists be entrusted; so HASSKARL was charged with the direction of *Cinchona* culture in Java, and acquitted himself of the task according to his powers till the commencement of 1856, when, in consequence of continued weariness, constant application and perhaps also of disappointments without end, he became ill and found himself obliged to return to Europe, about the middle of the year.[3] Dr. F. JUNGHUHN was enjoined to take over HASSKARL's work and to continue it.

What was it meanwhile that had taken place there at that time and previous to HASSKARL's mission?

Many years previously, a plant which had been sent to Java by MIQUEL, was planted in the hospital garden at Weltevreden, and there was long considered to be the true *Cinchona*. In 1856 I saw the plant, then a healthy bush, but it had been known for some time, to be nothing else than *Cascarilla muzoniensis*.

[2] In English feet = 16404. B. D. J.

[3] Dr. CARL MÜLLER gave a long account of HASSKARL's noteworthy travels, in the "Deutsche Revue der Gegenwart" for 1873. The whole question of the introduction of the *Cinchona* tree into Java, was taken up by Dr. W. H. DE VRIESE in an interesting pamphlet in 1855.

In 1851 there was in Paris a true *Cinchona* plant belonging to the best species, *C. Calisaya;* it was raised from seed, collected by WEDDELL in America. Professor DE VRIESE received this precious specimen from MM. THIBAUT et KETELEER of Paris, in exchange for certain Indian plants. Transferred to the garden of the academy of Leyden, it was afterwards placed with the greatest care in a specially prepared case and dispatched to Java, 1st December 1851, by the sailing vessel Frederik Hendrik, P. HUIDEKOPER, master. In April 1852, TEIJSMANN, the curator of the state botanical garden at Buitenzorg, received this firstling. It had suffered so much, that it could not be kept alive, but thanks to TEIJSMANN's care, one cutting was obtained before it succumbed, which developed robustly and was transferred to Tjibodas in the Gédé range of mountains, the so-called strawberry garden of the Governor General, about 4400 feet above the sea.[4] The diligent TEIJSMANN quickly obtained a new individual from this plant, itself once a cutting, and the specimen booked as Calisaya No. 2, obtained a place close to the parent plant, between the thick roots of a hewn down, gigantic forest tree. Though this situation may seem very narrow and confined, experience had taught the skilful propagator to reckon precisely on it, that on the other hand, an excellent shelter would be secured for the tender nursling.

The parent tree and its offspring vied with each other in rapid growth; according to the observations of 1st January 1856, No. 1 had developed to 3 metres, and No. 2 to 2¾ metres. In July 1859 the dimensions indicated were 16 and 15 feet, and in January 1865, 28 and 24 feet. In 1866 No. 2 (the cutting obtained from No. 1) began to languish, and then threatening to die, it was sawn off about 2 decimetres[5] above the ground. The tree of about fourteen years old had reached a height of 8.125 metres, with a circumference round the trunk of 0.8 metre. 10 kilos of dry bark were obtained from the sawn off stem, whilst if the tree had been dug out, and the bark harvested from all the branches, the stump, and the roots also, the outturn would certainly have amounted to 12 kilos. A large piece of the sawn trunk was forwarded to Bandoeng, and being of historical value, it is carefully preserved in the office of the Director of the government *Cinchona* culture. In the same way, disks were taken from the handsome stem with the bark still on, and sent to the Colonial Museum at Haarlem. The tree No. 1 remained several years alive, and attained considerable dimensions; from the stump of No. 2, numerous, robust suckers sprang up; but the original *Cinchona* establishment was abandoned about the year 1866, and attached as a section to the state botanical garden. Special care being no longer demanded, the nurseries for *Cinchona* cultivation were transferred to the central range of Preanger, and then, as the original trees at Tjibodas were no longer necessary for propagating, they had less attention devoted to them, so that at the present time, they probably are no longer to be found.

It will presently appear that the two nurslings so often mentioned had their full share in the multiplication, and thereby must constantly have been subject to severe treatment. Thus, for the purpose of chemical investigation, strips had been repeatedly cut from the bark of the stem,

[4] In Paris feet, or 4812 English feet. B. D. J.

[5] Nearly eight inches. B. D. J.

all of which taken together from these two, as well as from all the remaining original *Cinchona* trees at Tjibodas, so much and so long experimented on, in every shape and form, that their tenacity of life may be appreciated now that they did not succumb more speedily and in greater numbers. In the barks of *Calisaya* 1 and 2, from 5 to 6% of alkaloids were found, under different circumstances, and by various analysts, produced for the most part as quinine and its analogous compounds.

We were therefore right in hoping we possessed the best and richest description of *Cinchona*, and it is not to be wondered at, that the endeavour was to increase the number of individuals of such excellent quality by artificial propagation, as rapidly as possible. The trees flowered repeatedly but the flowers always withered, and fell off without setting fruit. From 1864 onwards, the trees at Tjibodas were allowed to rest, and in the year named, two of the specimens in the strawberry garden were manured. In 1865 they yielded some well developed capsules, from the seeds of which a few young plants germinated and were planted out at Tjineroean in the Malawar range. The seedlings did not wholly resemble the parents, but by progressive development, the majority at an advanced period of life, came to resemble small trees showing single, unmistakable, important deviations, amongst other things, in hairiness of the leaves.

The strawberry garden at Tjibodas, where the two parent trees stood isolated, was so far separated from the higher situated *Cinchona* plantations, where other species occurred, that it was hardly possible to suspect hybridization, unless insects might have conveyed the pollen from the trees at a higher station; the wind though could not be the carrier, for a broad strip of forest between both sections of the nursery was left untouched.

We shall subsequently see that bastards or varieties are mostly obtained by multiplication by seeds, and that these, harvested from one tree and at the same time, as a rule produce plants, very various in appearance and form. It is well to remember that from seeds brought by WEDDELL from America, hybrids or varieties were already derived (see Vol. 1, p. 61 of my book, *De Oost-Indische cultures in betrekking tot handel en nijverheid*, where the distinguishing points of hybrids are considered), and in this case it is explained, that in the seedlings the characters of both the parent-trees revert.

With regard to quality, it appeared in the course of time, that the barks just described were not in reality so good as the first repeated analytical results had declared. Since chemistry has taught how to separate with greater nicety the various *Cinchona* alkaloids, analysis brought to light the fact, that much of the pretended quinine in the *Calisaya* barks, Nos. 1 and 2, was nothing else than quinidine and the so called amorphous alkaloids.

Having thus in a short space sufficiently recounted the history of the first *Cinchona* plant which reached Java, we must now return to HASSKARL's mission and closely follow up its results.

We have mentioned in passing, that HASSKARL during his stay in America, sent seeds to the Netherlands. According to his statements, these were derived from two varieties of *Cinchona Calisaya*, and also from *C. ovata*, *C. amygdalifolia*, and *C. pubescens*. Some of these seeds, were, with the powerful coöperation of DE VRIESE, immediately sent to India, and the remainder were entrusted for sowing, to the directors of the botanic gardens in the Netherlands.

In Java, the curator TEIJSMANN was naturally selected as the man to take charge of the treasure thus acquired. TEIJSMANN knew that the home of the *Cinchona* was in the higher, cooler, mountain zones, and at Tjipannas, Tjibodas, Tjibeurem, and Kandang-batak, respectively about 1200, 1290, 1460, and 2372 metres above the sea,[6] he, with the assistance of the skilful superintendent TEUSCHER, laid out numerous and extensive nursery-beds, on which the seeds were sown with the greatest care, and provided with the needful protection.

These estates were chosen, for the simple reason that no other land under TEIJSMANN's supervision was available. He gave an account of his proceedings in letters dated 30th January 1854, to which he added a proposition, that in order to en sure the germination of the seeds, a commission of experts should be nominated, whose function it would be, to trace out suitable lands, and to determine their elevation. He further urged the experimental culture of *Cinchona* in selected places, not confining it to that region, but also seeking elsewhere for suitable land.

With this reminiscence, borrowed from authentic sources, we join in a hearty protest against the accusation, so often rumoured, that TEIJSMANN "obstinately and irremovably clung to the purpose of fixing the future *Cinchona* culture, exclusively to the Tjibodas estate." Whoever at the present time, ascribes the sad ending of the Tjibodas Cinchona plantation to TEIJSMANN, simply shows insufficient acquaintance with the facts, and besides, inattention to the history of the plantation. It would be useless, and here at least is not the place for it, to awaken old quarrels, or to take sides with this or that champion, but esteem for TEIJSMANN's industry compels us to place the facts in their true just light, and as we were never infatuated with the idea of an extended *Cinchona* cultivation on the narrow mountain ridge on the northwest aspect of the Gédé range, we may not deny, that the soil and climate at least did not appear unfavourable there. The two oldest *Calisaya* trees, and many others, of 10 to 14 years old planted still higher, which we have visited repeatedly, have always astonished us by their strength and active development, in spite of the mortal experiments to which as will immediately be shown, they were subjected when young by attempts at artificial propagation.

How many of the previously mentioned intended nursery-beds succeeded, we cannot say for certain. The plants resulting therefrom, with those subsequently brought from the Netherlands, raised from the seeds entrusted to the various botanic gardens, were put out at regular intervals of 20 feet, in the specially cleared ground. In December 1854 HASSKARL himself came over, and brought with him specimens from America, though it seems uncertain what this number was. On the first of January 1856 there were mentioned as being at Tjibodas, the two *Calisayas* in the strawberry garden, respectively 3 and 2.75 metres high, 42 *Calisayas* and 60 *Ovatas*, raised from seeds. Amongst the plants

[6] In English feet 3637, 4232, 4790, 7546. B. D. J.

introduced direct from America, there were three, 0.8, 0.5 and 0.25 metre high. The weather was unfavourable at the beginning of 1856; many plants were damaged by violent winds, and the frequent showers did much harm. By this time 238 *Calisayas* and 50 *Ovatas*, had been obtained from cuttings. It was said in the earliest reports, that the plants showed a strong inclination to branch quickly, and these branches made suitable cuttings. On attentively going over the monthly reports in succession, it will be perceived, that HASSKARL and JUNGHUHN also, by persevering, accomplished much by making cuttings, although it becomes apparent thereby, that relatively few grew up to plants, though JUNGHUHN states in one of those reports, that not more than 10% of the cuttings failed.

The truth is, as we have found during eleven years, when we could avail ourselves of riper experience and better means, that, except in *C. succirubra* and *C. officinalis*, cuttings as a rule, are most troublesome and deceptive. If well put in, and looked after, cuttings will sometimes for months maintain a favourable outward appearance, and some will even seem to grow. If however they are examined more closely, there will be found little or no sign of rooting, but on the contrary, at the base of the cut surface, a knob shaped thickening, the so called *callus*.

Now we can imagine, that at first the propagators allowed themselves to be deceived by these appearances, and that they seemed to see thrifty, healthy plants, while they really were merely fresh and green cuttings, without a good system of roots. Such individuals planted out in the open ground, must as a matter of course speedily die, and we must seek in this direction for the explanation of numberless disappointments, which were constantly experienced in propagating, when this was not accomplished by means of fresh, well developed seeds.

So also at the present time it does not seem strange to us that so few plants germinated out of the mass of seeds sent by HASSKARL. Granted that they were in a germinative condition, it remains still a fact, that the older the seed, the more difficult to start it into growth, and if many even now are lost from fresh, healthy seeds, sown broadcast on beds however protected against wind and weather, etc., it is evident that but little was to be expected from seed that had travelled far, was neither new nor fresh, and treated in the way above mentioned. From 1864 onward, we have repeatedly received *Cinchona* seeds direct from America, or via the Netherlands, and by another method of treatment, which we shall describe hereafter, we always obtained a satisfactory number of plants. If the seed sent by HASSKARL had yielded results in proportionate measure, Java would in 1855 already have rejoiced in the possession of many thousands of *Cinchona* plants. But the properties of the *Cinchona* seed were to be learned only by costly and tedious experience. The cultivator TEIJSMANN himself, who had by the end of 1853 extensive beds, sown with *Cinchona* which judged from our present standpoint, really obtained no results worth naming, taught us in March 1864 a method of germinating seeds which we have always found excellent, even when we had to do with seed no newer and even worse cared for, than that sent in quantity by HASSKARL.

On the first of May, 1856 there were recorded at Tjibodas, 43 *Cinchona Calisaya*, 76 *C. ovata* and 3 *C. lanceolata* besides 865 cuttings.

The total number of plants was thus actually lessened by one *C. Calisaya*, but increased by 15 *C. ovata*. The *C. lanceolata* which are here enumerated for the first time, appear later on to be identical with the *C. ovata*, or at most only a variety of it.

In the strawberry garden the two oldest *Calisayas* continued growing, and there also we find mentioned a specimen of *Cinchona pubescens*, introduced as we suspect from the Netherlands. This plant did not long survive, at least it was soon omitted from the reports, and it may be left out of our reckoning, for no propagation of it seems to have taken place. This single specimen had reached a height of 0.5 metre.

The latest reports of HASSKARL concerning Tjibodas, are dated 2 and 3 July 1856, and are compiled from data of the superintendent TEUSCHER on duty there.

According to this official report there were on July 1st as follows, 113 *Cinchona Calisaya* and 88 *C. ovata*, the latter better developed than the former. JUNGHUHN who on the 3rd July following personally inspected the condition of the plantation, reported only 63 plants in all, 37 being *C. Calisaya*. The dimension of these were, 26 under, and 9 above 0.25 metre; the two others had reached a height of even more than 0.5 metre, whilst of *C. ovata* only 8 specimens attained more than 0.275 metre. With the transfer of the direction of culture, there was thus suddenly brought to light the inaccuracies, for which HASSKARL, then already under treatment in the hospital at Weltevreden, can hardly be blamed.

Quite in accordance with TEIJSMANN's representations of 30 January 1854, JUNGHUHN had already succeeded in directing the attention of the Dutch government to the excellent situation for an extension of *Cinchona* culture offered by the central mountain range of Preanger. He had moreover weighty objections to Tjibodas, and also in a general way, against clearing the Gédé range.

The objections consisted in the unfavourable formation of the ground, the want of shelter against wind and of water supply, the inadequacy of the ground, as well its quality and lastly the impending danger from the active neighbouring crater. Above all, JUNGHUHN considered the plantation to lie too low.

In the Malawar range (Zuid-Bandoeng, about the centre of the Preanger regency) there was not one of these drawbacks; on the contrary every condition was favourable, both in regard to climate and soil, as to the formation of the ground and the amount of suitable lands disposable. JUNGHUHN visited this region first in October 1839, and all his subsequent writings and actions testify to his great liking for this neighbourhood. At that period, there was nothing to be found but boundless, impenetrable forests, in which the only open spaces were due to the sulphur springs of the Wajang mountain, and a few warm springs close by. The entire tableland of Pengalengan, within the vertical limits of 4400 to 4500 feet above the sea,[7] estimated to be 9 kilometres from east to west, and fully 10 from north to south, was covered with forest to the tops of the surrounding mountains. No other mountain district exists in Java which can vie with this, in its great extent, proportionate height and favourable situation. Towards the close of 1839 a *passangrahan* (resting place for officials and travellers) was built, an

[7] Respectively 4812 and 4921 in English feet. B. D. J.

opening made in the forest at the most suitable point, and a road constructed. From this point, the forests were begun to be cut down, and plantations laid out; this increasing year by year, ended by taking in a considerable portion of the higher lands.

JUNGHUHN had fixed his eye upon this region, so highly favoured by nature. Here would be room for an almost unlimited extension of *Cinchona* culture, and in these highlands, which offered the most striking resemblance in climate

DE

UITKOMSTEN

DER

KINA-KULTUUR

IN

NEDERLANDSCH INDIË,

IN 1856;

DOOR

**W. H. DE VRIESE,**

*Lid der Koninklijke Akademie van Wetenschappen.*

MET EENE UITSLAANDE PLAAT.

AMSTERDAM,
C. G. VAN DER POST.
1857.

FIGURE 60. — FRONTISPIECE OF ONE OF THE NUMEROUS REPORTS ISSUED BY NETHERLANDS SCIENTISTS DURING THE SECOND HALF OF THE NINETEENTH CENTURY ON THE DEVELOPMENT OF *Cinchona* CULTIVATION AND VARIOUS RELATED EXPERIMENTS IN JAVA. — *Courtesy Arnold Arboretum of Harvard University.*

and vegetation to the native land of the *Cinchona*, these plants brought from South America would not feel strange. The similarity is really remarkable enough to warrant the hypothesis, that here the *Cinchona* tree would have to undergo a process of naturalization, rather than acclimatization.

JUNGHUHN started to return on the 1st September 1855 by the sailing vessel "Minister Pahud" (W. PFULL, master), bringing with him the *Cinchona* plants which had been left in the Academy garden at Leyden. Timely information had previously been given to the Indian government, so that regulations could be drawn up for the speedy transmission of the plants on their arrival at Batavia, to the place chosen by JUNGHUHN at Pengalengan.

HASSKARL charged himself, during the close of 1855 with making the ground ready for the reception of the new guests. Two kilometres northeast of the *passangrahan* Pengalengan, the centre of the extensive government coffee plantations, and above these, a space in the forest of about 300 feet in length, and the same in breadth, was cleared with the utmost celerity. From the stream which there flows, the future establishment was named Tjinieroean, 1566 metres above the sea.[8]

JUNGHUHN had come back with four cases of a special construction, the so-called Wardian cases, containing 55 *Cinchona Calisaya*, 88 *C. ovata*, and 6 *C. lancifolia* plants, which whilst on board, one with another, had reached the height of 1 to 1½ feet. Arriving at Batavia in the first week of December, JUNGHUHN reported to the government, that he had succeeded in bringing over 139 plants out of 149, in a perfectly healthy and fresh state. During the voyage, the plants had grown so much, that their diligent guardian was obliged to cut off some of the tops, which were put in as cuttings.

On hearing of the arrival, HASSKARL hurried to Batavia, to transport the new treasure himself to Tjinieroean. By the 2nd of February he was compelled to record the death of 4 *C. Calisaya*, and 18 *C. ovata*. Most of the plants seemed to lose their leaves and buds, so that they really looked greatly diminished in general aspect. On the other hand, the same plants had a tendency to bud out at the bottom of their woody stems. This appearance was a natural consequence of the topping practised by JUNGHUHN.

By HASSKARL's report there now remained only 103 plants, that is, 46 *C. Calisaya*, 50 *C. ovata*, and 7 *C. lancifolia*. The biggest plant was 0.2 meter high.[9]

We must here remark, that the *C. lancifolia* plants were not derived from seeds collected by HASSKARL. The Berlin professor, Dr. KARSTEN, traveling in New Grenada, had there procured seeds, which by exchange with the Governor of Surinam, were presented to the Dutch government. From these, 6 or 7 plants were raised in the botanic garden at Leyden, which reached Java under JUNGHUHN's care.

About the same period as the dispatch of the "Minister Pahud," there were shipped to India by the "Corigene" (RIJKEN, master), 106 plants, which were raised in Utrecht. This consignment did not receive skilled supervision, and thereto it must be ascribed that although these plants were dispatched forthwith to Tjinieroean, according to HASSKARL's report, not more than 7 came to hand in a fresh state, and 13 in a doubtful condition.

On the 1st April there were only 40 of JUNGHUHN's plants, C. *Calisaya*, 33 *C. ovata* and 6 *C. lancifolia* still living; whilst of the Utrecht consignment not more than two remained.

Dating from Tjinieroean, HASSKARL presented another report, with a description, of the *Cinchona* varieties indicated, accompanied by *C. Calisaya* leaves of five different forms, to show that the form of leaf differs remarkably in individuals of the same species. The report and appendices

[8] That is, 5140 English feet. B. D. J.

[9] Not quite 8 inches. B. D. J.

were sent to the Netherlands for the opinion of DE VRIESE, who confirmed the accuracy of HASSKARL's statement. It was of the utmost importance, to know whether we really possessed the true *Cinchona Calisaya* because this species was generally considered to yield the barks richest in quinine. DE VRIESE had kept back a few plants, and on his proposal WEDDELL, who was still held to be the highest authority in the domain of quinology, was invited to inspect this treasure and pass his opinion thereon. This took place at Leyden, on the 27th September 1855, and whilst still at a distance, WEDDELL recognised and distinguished amongst the plants, "the true *Calisaya*, and nothing else, without the slightest doubt."

It is necessary to bear in mind, that at this time, only young plants were to be had for investigation and determination. As peculiarly characteristic of *C. Calisaya*, the *scrobiculi* and the dull velvety appearance of the leaves were relied on, although this last is due to a special condition of the cells of the upper surface of the leaf.

How deceptive these characters are, and how difficult it is to distinguish even developed, flowering, and fruiting *Cinchona* trees, will be seen later on. The *scrobiculi* do not serve as a special characteristic of the true *C. Calisaya*, for as we have already shown, they are also met with in other species, though certainly *not* in the species then called *C. ovata*.

On the other hand, *C. ovata* displays in its young state, as plainly, its peculiar velvety surface. One after another fact was cleared up by the dispute which ensued later as to specific determination, as also the fact that the original names seem to be not entirely irreproachable.

In June 1856 HASSKARL returned to Europe, resigning the prosecution of *Cinchona* culture to JUNGHUHN.

With this transference of management, the first period of the new culture was closed. There was now a trial plantation at Tjibodas, disapproved of by JUNGHUHN as already stated, and a second at Tjinieroean, which estate he considered to lie too low, whilst he moreover deplored the planting out of *Cinchona* trees on cleared ground, he had there placed them under the shade of intentionally planted *Dadaps*.[10]

JUNGHUHN also saw a threatening danger in the circumstance that the stumps and roots of the felled forest trees were left in the ground; in his opinion the vegetable portions would proceed to rot, and in every respect open a favourable opportunity for cryptogamic vegetation, of which the developed *mycelium* would overrun and kill the delicate *Cinchona* plants. The fact that afterwards, sickly or dead *Cinchona* plants were met with, attacked by *mycelium*, gave support to JUNGHUHN's suspicions and fears. Meanwhile we may now, by reason of many years' experience on hundreds of hectares of ground cleared and again planted, declare with the greatest possible certainty, that the causes of the deaths of the *Cinchona* plants did *not* lie in the method of clearing and planting.

JUNGHUHN's first report was dated 25 July 1856. Besides the 7 *C. Calisaya* and one specimen of *C. pubescens* in the strawberry garden at Tjibodas, there were then recorded in the plantation, 41 *C. Calisaya* and 65 *C. ovata*.

[10] Various species of *Erythrina*. B. D. J.

A mighty revolution was begun in the Malawar range. From Pengalengan to the summit of the mountain, were twelve nurseries made, adjoining in a straight line, Tjinieroean being one, which was already made by HASSKARL. These collective trial nurseries now lodged 143 plants, 66 of which were at Tjinieroean, JUNGHUHN now distinguishing 7 as *C. lanceolata*. In the higher plantations there were placed 56 *C. Calisaya*, 77 *C. ovata*, 7 *C. lanceolata*, and 3 *C. lancifolia*, all protected with the greatest care against injury by animals, etc. The plants brought by JUNGHUHN himself from the Netherlands, were all at Tjinieroean, those higher up the mountain, were derived from Tjibodas, where the oldest individuals, and the more difficult to remove, were destined to remain to supply cuttings, under the care of the superintendent SWART.

In August 1856, the first propagating house at Tjinieroean, 18 feet long and 13 feet wide, was finished; JUNGHUHN was hard at work to turn the Malawar range into an English park, by making roads, leading from Tjinieroean to the upper regions, which cut through the primeval forest in various directions. Above Tjinieroean, in the middle of a thick, majestic forest, at a height of 5790 feet, a small *passangrahan* was built, and ground cleared. From this place, Gedong-banteng, JUNGHUHN wished to regulate and watch his projected gigantic labours.

On 31 August 1856 there were enumerated; on the Malawar range 143 and at Tjibodas 105 plants; the latter were mentioned by JUNGHUHN as being already great heavy trees. Some hundreds of cuttings (as the small branches or ends of branches when cut off are called) were taken from these every month, which were then wrapped in *pisang* (*Musa*) leaves, and sent to Tjinieroean, and there received in the propagating house.

It needs scarcely be told, that the first planted or transplanted young trees were placed by JUNGHUHN in the thick shade of the forest. It appears from everything, that he remained convinced that these conditions were the prime requisites for a good and lasting development of *Cinchona*. At first the young nurslings were put on along the newly constructed roads, and thus had, relatively at least, more light and air, than the rows which were later made, at distances of 25 feet apart, in the thick forest.

Both undergrowth and trees alike were felled; the ground cleared simply of weeds, and the *Cinchona* turned out into a deep, broad hole, so that they were at least from six inches to a foot when settled, above the trodden ground, in consequence of breaking up the soil in the hole, after which they were provided with stout fencing. In this fashion gradually a hundred thousand *Cinchona* plants were systematically planted out in the forests of Malawar, Wajang, Kendeng, Wringin, Patoeha, and Tangkoeban-Prahoe ranges.

In October 1856 JUNGHUHN's expectations of the near future were so great, that he drew up an outline of instruction for the officers, charged or about to be charged with the superintendance of *Cinchona* culture, and of rules for the foremen in that department. A preliminary Guide to the culture, soon saw the light namely in 1858, and even from our present standpoint, it contains considerations and information in natural history and climatology of extreme interest.

JUNGHUHN on the 2nd November 1856, reported that 22 plants had died at Tjinieroean,

which he attributed to the still imperfect experience of the foreman; the remaining plants grew day by day.

At that time there was actually an experimental planting in the Ajang-range (Besoeki) in order to observe the influence of a drier climate.

JUNGHUHN carried out this plan on the 21st May 1859; 9 *Cinchona Calisaya*, 8 *C. ovata*, and 4 *C. lanceolata* were planted at that date at Wonodjambi, 2219 metres [11] above the sea, in very fertile soil, in the midst of the forest, each plant separately provided with a strong fence, since it would not be possible there to keep a constant watch.

Within two years, 3 individuals were dead, and when the writer of this visited Wonodjambi in September 1865, he found still there, 15 vigorous and tall trees, but in want of air and space, so that a thinning of the surrounding forests was greatly to be recommended. At the same time it appears that in 1859 young plants could not be clearly determined; for there stood prominently forth a handsome specimen of the species, which MIQUEL afterwards described as *C. caloptera*.

In 1863 JUNGHUHN planted on the cleared table-land Diëng; 2046 metres above the sea [12] behind the *passangrahan* there, in an enclosed nursery, 16 *Cinchona* trees, belonging to *C. Calisaya*, *C. Pahudiana* (formerly called *C. ovata*), *C. lancifolia* and *C succirubra* (met with amongst *C. ovata*, and at first called *C. cordifolia*, but afterwards *C. caloptera*), four of each species. When I surveyed this plantation in September 1865, there were still 14 freely developed bushes living.

At Tjinieroean meanwhile the dwellings of the foreman and the staff of workpeople, and the nursery accommodation were actively pushed on. On the 4th December it was said; all "plants in the open ground more than three inches high, are growing admirably, those in the frames satisfactorily; the cuttings root so fast, that they must be shifted into the largest sized pots. Tjibodas yields about 300 cuttings per month on an average, and this number will be increased to 500 or 600, as soon as sufficient nursery accommodation can be prepared at Tjinieroean." At Tjibodas they began at this time to take *tjangkokken*, or layers, from the biggest trees, by which means robust young trees could be readily assured.

The report of the 4th January 1859 states, that many plants in the open ground had died, in consequence of frequent rains, against which the insufficiently rooted cuttings appeared unable to contend. In future so far as possible, planting out will be done after the rainy season. At the end of 1856 at Tjibodas, there were still recorded, 41 *C. Calisaya*, and 64 *C. ovata*, and on the Malawar hills, 66 *C. ovata*, 62 *C. Calisaya*, 7 *C. lanceolata* and 3 *C. lancifolia*, without reckoning the cuttings in the propagating houses. Contrary to the great expectations cherished of the artificial propagation, and often repeated, the actual increase cannot be considered particularly satisfactory.

A new period of happy augury set in, when on the 10th June 1857, flowers were discovered for the first time on a specimen of *C. ovata* 9 feet in height. In August, 6 *C. ovata* from 8 to 12 feet, and 7 *C. Calisaya*, of 7 feet high each were flowering; JUNGHUHN remarked, that those branches on the *C. Calisaya* tree which were intended for layers, bore the most flowers. Amazement at this, surely testified to want of experience in propagating trees. The operation of *ringing* as a provocation or incitement to flower, was known long ago, and often in later years it has been applied with the happiest results to trees of *C. Calisaya*, *C. lancifolia*, and *C. caloptera*.

In the month of June 1869 JUNGHUHN noticed a specimen with a large leaf, amongst the *C. lanceolata* which was held to be *C. cordifolia* until more recent investigations and comparisons convinced him that here he had to do with *C. succirubra*. [13] But this opinion also seemed wrong, when he was able to compare this species, with specimens of *C. succirubra* received from British India in 1862, and MIQUEL recognised it as *C. caloptera*.

The pretended *C. succirubra* remained for years known to the labourers in the *Cinchona* establishments as *Kortefolia*, (short-leaf) and we also, previously to 1866, did not dare to doubt officially, its identity with the true *C. succirubra*.

MIQUEL undertook and completed the task of making an end of the existing confusion as to species. In arranging the material collected by HASSKARL in America, which was preserved in the Leyden herbarium, the expert systematist MIQUEL by set study and analysis, arrived at accurate botanical determinations. Where the data for a thorough investigation failed, the plantations in Java were able to supply them. We had the privilege of supplying the eminent botanist with important and desired material, and numerous questions concerning the natural occurrences of the living tree were readily and with the greatest exactitude answered.

In 1869 the fruit of his labours saw the light; it was entitled: — "De Cinchonae speciebus quibusdam, adjectis iis quae in Java coluntur," Amstelaedami (C. G. van der Post).

MIQUEL's declarations were not implicitly received on all sides; as for ourselves we had no definite reasons for doubting the accuracy of his botanical determinations, although we could advance certain objections to the estimated values of the species and varieties investigated, on the strength of the chemical analyses which were made in Java.

It would lead us too far, were we to follow minutely the official reports as to the history of the development of *Cinchona* culture in its second period, under JUNGHUHN. Many times and in many ways it was faulty, but it was an experimental field in the fullest sense of the word, and conclusions and deeds of the most apparently logical kind could only expose the experimenters to disappointment so long as experience had not yet, by means of long practice, decisively declared. A man like JUNGHUHN stands too high, for the errors which arose under his superintendence, to depreciate his well merited fame and name. His unbounded love of nature, his unwearied diligent endeavours, his clear and sharp insight, and his comprehensive knowledge, speak in his numerous and most important writings. JUNGHUHN's work in Java is unsurpassed of its kind at the present day, and will always remain a trusty, unmistakeable testimonial to the Indian

[11] In English feet, 7280. B. D. J.

[12] That would amount to 6713 English feet. B. D. J.

[13] According to OUDEMANS, HOWARD considered this plant to be *C. succirubra*, HASSKARL, however, had not visited the mother country of this species and so it must be considered strange or purely accidental if he had brought seeds of it thence.

naturalist. *Cinchona* culture has benefitted immensely by his information as to the most suitable soils for it, and his perseverance in accomplishing his task. His acrid criticism on his predecessors, TEIJSMANN and HASSKARL, criticism which indeed had no right to be made, is however to be deplored. If the course adopted by conviction by both these men, and dealings with regard to *Cinchona* culture did not coincide or agree with those of JUNGHUHN, this champion for light, right, and truth might have refrained from depreciating and discrediting the activity of his predecessors, through which his own mistakes and shortcomings, were more or less hidden.

The acclimatization experiments have set loose debate, in which many have taken part, both Dutch and others. It becomes an international question, in as much as all civilized peoples must have an interest in the success of the attempts to subject *Cinchona* to regular cultivation outside its native land.[14]

[14] Among the many foreign periodicals, which have applauded the success of HASSKARL's mission as a triumph of science and civilisation in the cause of humanity, we may name, HOOKER's "Journal of Botany" — the "Annuaire des deux mondes" of 1855, and various Journals and Reviews of the United States etc.

We will not interfere with the contentions of passion caused by devotion to the object, perhaps also a little by vanity. Henceforth we have merely to do with actual facts, and by them, to ensure a clear exposition of the whole history, which may serve as fruitful instruction, and as sure guidance to planters of the present day, as well as those of the future.[15]

In 1867 ROCHUSSEN wrote:

"The eyes of Europe are fixed upon this enterprise, which interests it in the highest degree; for it is, so to speak, to procure for the sick, the means of life, and to procure it at a cost which will not exceed his means. This is no common speculation, it is a humanitarian work that the Dutch government has undertaken and carried it out; it does not wish for monopoly; it does not hide it under the veil of secrecy."

Even so lately as 1864, it was expressly stated by decree of the Indian government of February 14, that the culture of *Cinchona* must not be regarded in any aspect as a financial speculation.

We know today that the sacrifice made on behalf of humanity, has actually in the end, succeeded fiscally, and also as private undertakings.

[15] It long was a great mistake in British India, as well as in Java, that the concern was much more for what might be, that is to say, for what was hoped for, — than for what was. Many disappointments were felt by going too fast and too far, which would not have been experienced in calmly working on.

# Chapters in the History of Cinchona
# III, JUNGHUHN AND CINCHONA CULTIVATION

*by* P. VAN LEERSUM (1854–1920)*

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Early in the eighteenth century, the crude native methods of harvesting the cinchona bark from the forests of America had created a grave danger: the valuable trees were likely to be completely destroyed.

When this danger had risen, many different methods of saving the wild plants had been tried, but only one, deliberate cultivation, had seemed at all effective.

However, domestic cultivation required both seeds and plants and they would have to be secured and brought to Java. Accordingly, Governor General PAHUD of Java requested JUNGHUHN to go to America for seeds and stock. JUNGHUHN was willing to make the trip; but, for various reasons, he recommended that HASSKARL, whom he had once known in Java and who was now in Holland looking for a position, be sent.

So it happened that, in December 1852, HASSKARL left Europe for South America and, on December 12, 1854, reached Batavia with twenty-one cases of cinchona plants and a large quantity of seeds. Of the five hundred plants in the shipment, only seventy-five were still alive when they arrived at Buitenzorg. They were sent to Tjibodas, 1,527 m. up the eastern slope of Mount Gedeh.

In the meantime JUNGHUHN had left Java to spend a leave of absence in Europe. He returned in December 1855, and in June of the following year, because HASSKARL had left Java, was given the management of the cinchona plantings.

At that time there were 167 cinchona trees growing in Java, of which 96 were of the *C. ovata* group named *Cinchona Pahudiana* Howard. Six and a half years later, under JUNGHUHN's energetic direction, there were 1,359,877, of which 955,708 were *C. Pahudiana*.

The foremost of all JUNGHUHN's contributions to the cultivation of cinchona was his wise selection of the best possible site in Java, the Pengalengan and Bandoeng plateaus and the southern slopes of the mountains. No other region in the entire archipelago is so well suited to the growth of cinchona. When one compares this site with the other regions where people from several countries have tried a similar cultivation only to fail or be but partially successful, he can appreciate JUNGHUHN's discernment in making his choice.

Consequently, three-fourths of all the cinchona bark in the world and ninety-five per cent of all the bark used for the extraction of quinine comes from Java.

Another of JUNGHUHN's contributions to the cinchona industry was his realization that a knowledge of chemistry is essential. He devoted much time to the study of the chemistry of cin-

* This translation has been prepared after Mr. VAN LEERSUM's chapter (JUNGHUHN's Verdiensten voor de Kina-cultuur op Java, 1856–1864) *in* "Gedenkboek FRANZ JUNGHUHN, 1809–1909" (The Hague: Nijhoff, pp. 199–226).

chona. It is noteworthy that his tentative conclusions have not been supplanted.

Naturally, there has been much criticism of JUNGHUHN's work. For instance, he was reproached for (1) planting *C. Pahudiana* instead of *C. calisaya* and (2) planting cinchona in the shade.

In his own defense, he wrote from Batavia in the first half of 1863 (reprinted by the "Java-Bode," nos. 19, 20, and 21) to one of his critics as follows:

"Refutation of some Objections which have been made in published articles regarding cinchona cultivation in Java"
by
FR. JUNGHUHN*

"I cannot answer all the objections which have been made in the Dutch, English, and German papers against cinchona cultivation in Java; yet it is my duty as a public official to render an account to the government. The government, through proper channels, has the right formally to question me concerning my management of cinchona cultivation, and if it wishes, to control my actions, to give me detailed directions, or to discharge me, if I have in any way been remiss.

"I shall, therefore, offer a few short explanatory notes to the readers of this publication and especially to one of the critics of cinchona planting in Java who, by virtue of his contributions to the publicity of different branches of science in India, deserves respect. This critic is Baron Dr. W. R. VAN HOËVELL, who has based his comments on observations made by CLEMENTS R. MARKHAM in his *Travels in Peru and India.* In the Tijdschrift voor Neêrlandsch-Indië (vol. 24, Dec. 1862) under the title "De kinakultuur op Java beoordeeld in den vreemde" (Cinchona cultivation in Java criticized abroad), he has spoken very unfavorably about this project in Java.

"To throw the right light upon such an expression of disapproval or even denunciation, it is necessary to decide in how far the critics are competent to express impartial views and at the same time to pass judgments. The British government sent MARKHAM to South America to collect cinchona plants and seeds. He returned to India with almost nothing. The seeds of *C. succirubra*, a species which forms the great asset of the British Indian cinchona plantings, were not collected by him but by SPRUCE. MARKHAM's shipment was lost. For this reason the British Indian government negotiated with Java for cinchona seeds, a large quantity of which could be obtained here for one-hundredth part of the cost of MARKHAM's fruitless expedition. According to writings of his fellow countrymen in Calcutta, MARKHAM was so angry at this interference that he expressed his disapproval particularly of *C. Pahudiana*. Other Englishmen say MARKHAM had little knowledge of botany or of any other branches of science, and that he was chosen, contrary to the advice of such scientific men as HOOKER and HOWARD, to go to South America solely because he understood a little Spanish. His ignorance of botany is revealed clearly enough from his own story of the journey. For example, in the description of the general appearance of the forest, he uses a conglomeration of some twenty plant names casually gleaned from works of other authors, but he does not indicate to the reader whether or not they are small herbaceous plants or tall forest trees. The opinion of this man, when it is not confirmed by obvious facts, has little significance. But this apparently VAN HOËVELL did not know.

"Now, will the reader kindly observe with what pleasure VAN HOËVELL in his paper speaks of the "nietswaardige Pahudiana" (worthless Pahudiana), a name he calls the plants each time, thus deciding for himself whether this otherwise able writer (MARKHAM) is competent to judge impartially of the cultivation of a plant named in honor of C. F. PAHUD.

"The five objections he made, following MARKHAM, are as follows:

"1. *Cinchona Pahudiana Howard is a worthless species because it produces too little quinine.* It is a known fact that the bark of the young cinchona tree contains no quinine, but that the quinine content increases slowly as the tree grows older and the bark thickens. This fact has recently been confirmed through the investigation of research workers on the Austrian frigate Novara (see Part 3, p. 357 of its voyage). In trees three, four, and eight years old there has been found .3%, .6% and almost 1% of quinine, respectively; while the bark of the roots has contained even more than 3%. Bark scarcely more than 1 mm. thick was taken from the very slender trunks of young trees which apparently would reach maturity in twenty-five or thirty years. Indeed, a comparison of *C. Pahudiana* with other cinchona species in all plantations shows that *C. Pahudiana* may be a much larger and taller forest tree than any other which we possess. Consider, for example, *C. Calisaya.* An eight-year-old tree of this species is much branched and practically mature, whereas an eight-year-old tree of *C. Pahudiana* is relatively much younger and will continue to grow taller, for this reason the trunk and the bark have not yet thickened. I have observed that, in many of the native forest trees of Java, when the tree is young and growing, the bark is no thicker than that of a *C. Pahudiana* tree of the same height, although the mature trunks of the same species are covered with a bark from one-fourth to three-fourths "rhijnlandsche duim" (inch) thick.

"The thick bark of full-grown cinchona trees does not contain more than 1.1% of quinine in *C. lancifolia*, 1.2% in *C. lanceolata*, 1.7% in *C. succirubra*, and 2.5% in *C. Calisaya* according to DELONDRE and HOWARD. Now, since our plants are still young and the almost paper-thin bark from young trees of *C. Pahudiana* has already yielded 0.9% of this precious alkaloid as compared with 1.1% in the mature bark of *C. lancifolia*, the latter being classed by all quinine manufacturers as one of the best, I cannot possibly call *C. Pahudiana* a worthless species. It is an established fact that the quinine content gradually increases as the bark becomes older and thicker, and that this thickening takes place slowly. However, it is likewise a known fact that trees of *C. Pahudiana* continue to grow taller and their trunks, therefore, continue to elongate. What other conclusion can naturally be reached than that as the bark becomes thicker the percentage of the alkaloid increases as the tree approaches maturity?

"The time is not far distant when the oldest

* Original title: "Toelichting van eenige tegenwerpingen, welke in gedrukte geschriften tegen de kinakultuur op Java zijn gemaakt."

of these trees will have attained a height of twenty-eight to thirty feet, at which time at least 0.2% more quinine will have been added to the 0.9% already present in the bark from young trees. If this be so, then *C. Pahudiana* will have the same quinine content as *C. lancifolia*, which is considered one of the best cinchona species. Past experience gives us the right to assume that the ripened and properly thickened bark of *C. Pahudiana* will produce at least 2% quinine. Another feature in favor of this species is the extremely small amount of cinchonine which, in some individuals amounted to 0.0%, as noted by DE VRIJ. Quinologists consider that a low cinchonine content is characteristic of good bark. Again it should be noted that HOWARD has found in the bark of *C. lanceolata* which HASSKARL forwarded to him 1.2% of quinine and very little cinchonine; consequently he accepted *C. lanceolata* as a desirable species. Also this *C. lanceolata* imported by HASSKARL into Java, a species originally described by RUIZ and PAVON and recently redescribed by HOWARD, is practically identical with our *C. Pahudiana*.

"In the correspondence of HASSKARL with HOWARD (see the 'Illustrations' of the latter), MARKHAM says among other things that HASSKARL has seen at Uchubamba certain small forests of cinchona trees which he has taken to represent the species *C. ovata* and which the natives called cascarilla vespilla chica. The description of the general appearance of these small forests does not absolutely fit our *C. Pahudiana*. I suspect that seeds of other species must have been substituted. This is not astonishing when one considers that HASSKARL bought his seeds from the cascarilleros; therefore, one can never be sure from which region or from which cinchona species such seeds were derived. Besides, we have found[1] one *C. succirubra* produced from his seeds of so-called *C. ovata*.

"That a species like *Cinchona Pahudiana*, which had perhaps for a long time furnished its quota of one kind or another of good quality bark, first became known after it was accidentally introduced into Java, is not surprising when one remembers that the red cinchona bark, one of the best, has been known and esteemed in commerce for a hundred years, while the species which produced it remained quite unknown. A few years ago, first SPRUCE and then HOWARD and KLOTZSCH, found this plant to be a new species. They called it *Cinchona succirubra* Klotzsch.

"Let us consider the good qualities of *Cinchona Pahudiana* in contrast to those of *C. Calisaya*. The former is a much larger forest tree than the latter and therefore will furnish a larger quantity of bark; it can be cultivated successfully at a higher altitude (4,500 to 7,500 feet; the zone for *C. Calisaya* is more limited); it can be propagated and acclimatized more easily, is more fertile, tougher and less sensitive to climatic changes; and, finally, it sprouts readily when the trunk is cut off above the roots. These advantages largely offset the earlier development of *C. Calisaya* and its quicker production of commercial bark. Admitting that the mature bark of a full-grown tree of *C. Pahudiana* contains ½% less quinine than does that of *C. Calisaya*, because of advantages mentioned above and the more abundant succeeding crop, total returns need not be less than those from *C. Calisaya*.

"2. *Cinchona Calisaya is relegated to the background by the increase of C. Pahudiana, and its cultivation is neglected.* To this I make the following reply. In 1856 there were extant 101 trees of *C. Pahudiana* and *C. lanceolata;* now (December 1862) there are 955,708. In 1856 there were 64 living trees of *C. Calisaya;* now there are 8,984. Therefore one can surmise that I have neglected *C. Calisaya*. Now the larger quinine content of the bark of *C. Calisaya*, wherein it excels all other cinchona species, is well known; and VAN HOËVELL can hardly have supposed that the extensiveness of the forests and mountains of South Bandoeng (not to mention still many other mountains of Java) where millions of *C. Calisaya* could be cultivated without hindering *C. Pahudiana* in the least, should have been a terrain unknown to me. Besides, he had already reached the conclusion that the smaller proportion of *C. Calisaya* in relation to *C. Pahudiana* could not have been brought about by disregard of its worth or by neglect. There must have been another reason. It is simply this: With the exception of a small number of plants which produced a few thousand seeds, the few trees of *C. Calisaya* which had blossomed and set fruit in the region from Tjadas to Tjibodas died before their fruit ripened. Thus, the largest part of the extant 8,984 trees of *C. Calisaya* were grown from seedlings in an indoor nursery which I had constructed at Tjiniroewan.

"Such seedlings develop roots in one and a half to three months. When, in 1856, the management of the cinchona cultivation became my responsibility, all sixty-four of the then living trees stood in open ground; hence it was not possible to multiply them by layering. After obtaining seedlings, I could have used this method to root other plants in about three weeks. In the meantime, however, I had gained experience which proved to me that cinchona plants grown from cuttings or layers are of little value. I shall elaborate this further in the following paragraph. I am pleased to state that in the fertile forest grounds of Mount Malawar eleven trees of *C. Calisaya* are beginning to bloom. Of these a few have flowered profusely; so before long the relative discrepancy in numbers between *C. Calisaya* and *C. Pahudiana* will disappear. Furthermore, this difference would never have arisen if the first planters of trees of *C. Calisaya* in Java had not established their plantations on the most barren soil that could possibly be found, that of Tjadas.

"3. *The increase of cinchona plants in British India in a year has been greater than in Java in six years.* Although this assertion is not exact, I shall not contradict it, but only note how the 72,000 cinchona plants, including 1,050 of *C. Calisaya* growing in British India on August 1, 1862 (according to a statement in the Tijdschrift voor Neêrlandsch-Indië) were obtained. From the printed report of MACIVOR at Ootacamund in the Neilgherry Mountains and ANDERSON at Darjeeling in the Himalaya Mountains (I am indebted for this report partly to the good will of His Excellency, the governor of Madras, Sir W. DENISON, who, through the intervention of the British consul at Batavia, sent it to me, and partly to direct correspondence with

[1] A professor of botany in the Netherlands has asserted that our *C. Pahudiana* was nothing but *C. carabayensis* Weddell. N. B. This is a shrub 1–3 m. high, its fruits furnished with strongly projecting ribs; in these characteristics it differs entirely from our species.

ANDERSON), it appears that, except for 463 of *C. succirubra*, the plants are propagated from layers. With these, between February and April 1861, the first foundations of the cinchona plantings in British India were laid. In addition, there were not quite 3,000 plants of *C. Calisaya* and *C. Pahudiana* obtained from Java or grown from seeds produced in Java. Again, in February, there were added 4,193 plants of *C. Condaminea* grown from seeds which, it appears, had been collected by SPRUCE in Peru, as well as a very small number of original plants grown from seeds of less familiar species. From these original or stock plants, about 8,000 in number, the greater part of the cinchona plants of British India has been obtained by layering at high tem-

VOORLOOPIGE HANDLEIDING

VOOR DE PROEF-

KINA-KULTUUR,

ZAMENGESTELD

NAAR EEN OORSPRONKELIJK GESCHRIFT

VAN

Dr. F. W. JUNGHUHN.

Artikel 1.

Bij de kultuur van den kinaboom behoort op den voorgronte staan, dat aan die plant, en wel aan iedere soort of ondersoort van dezelve in het bijzonder, eene groeiplaats in het gebergte worde aangewezen, alwaar de gemiddelde temperatuur zoo *juist mogelijk overeenstemt, met de gemiddelde temperatuur* der oorspronkelijke groeiplaats van iedere kinaboomsoort of ondersoort in Zuid-Amerika.

De aanwijzing der plaatsen in Nederlandsch-Indië, waar iedere kinasoort of ondersoort zal moeten worden geplant, behoort zooveel mogelijk te geschieden, op grond van gedane waarnemingen, door barometers, van de hoogte dier plaatsen boven zee, en, waar deze instrumenten ontbreken, door waarenemingen met thermometers van de standvastige bodemwarmte aldaar.

FIGURE 61. — FIRST PAGE OF JUNGHUHN'S 'Preliminary Guide to *Cinchona* Cultivation' (Natuurk. Tijdschr. Ned.-Indië 18:97–141, 1859, printed in Batavia). One year later this was followed by JUNGHUHN and J. E. DE VRIJ 'De Kinacultuur op Java op het einde van het jaar 1859,' pp. 99 (Batavia). — *Courtesy Arnold Arboretum of Harvard University.*

peratures in glass cases or hot beds. In this way they can actually be increased 1,000 to 1,200% in a year.

"In July 1856, when the care of the cinchona cultivation was assigned to me, I constructed hot beds and hot houses. However, I had at my disposal no 8,000 plants, but only 167 in addition to neglected sickly stock plants. Since these were already in open ground, I could at first increase them only by cuttings, which is a much slower process than layering. It is true that later, after I had obtained young shoots from cuttings and still later grown plants from seeds, I increased the number by layering. Nevertheless, I did this to only a small extent, since in the meantime I had learned from experience that only cinchona plants grown from seeds produce healthy, rugged trees; whereas those obtained from cuttings or layers, particularly those from *C. Calisaya*, grow slowly and very poorly, are lacking in vigor, and for the most part, after having produced flowers and fruits over a number of years, die before they reach full maturity. From the examination of many hundreds of dead specimens, among which were some received from British India,[1] I have found this to be the reason: Layers or cuttings of cinchona trees first develop roots only on the margin of the cut-off lower end of the stem or branch. A callus having formed, the roots spread in a horizontal direction (like a wreath), while the middle part, the naturally flat cut, remains constantly naked and rootless. Therefore, no true taproots are formed as in the plants grown from seeds. The earlier cut surface is subject to decay and to attack by subterranean parasitic fungi, by worms, boring beetles, and other pests. This is seemingly the vulnerable point or Achilles' heel of trees thus propagated.

"Our British neighbors in India will find this true in two or three years, when the great difference in the mode of growth and in the comparative mortality of plants grown from seeds and those from cuttings and layering will be evident. For myself, I do not envy them their 72,000 cinchona plants of which more than 62,000 originated from cuttings and layers, although I grant that the unusual diligence and the high degree of activity and capability which they have shown in multiplying their cinchona plants deserve the greatest praise.

"4. *In British India nine species of cinchona are now cultivated, but in Java only five.* This reproach does not concern me, but only the official whom our Government commissioned to go to South America, and who neglected to collect seeds of more than three species. It seems to me more or less fitting to clarify the statement. The British have three species of cinchona obtained from us: (1) *C. Calisaya*, (2) *C. lancifolia*, and (3) *C. Pahudiana*. (1) and (3) were imported into Java by HASSKARL; the other was sent by KARSTEN from Colombia. The British possess also (4) *C. succirubra*, of which we now have sixty-one plants propagated from a stock plant I brought from the Netherlands but of which I did not know the origin. We also have ten more sent us from India. We have a single specimen of (5) *C. micrantha*, received from India. But, because the bark of *C. micrantha* contains, in addition to cinchonine, only 0.2% of quinine, it is of little value. We do not have (6) *C. nitida*, but its bark contains no quinine and little cinchonine. According to HOWARD, it is of no value for quinine manufacture. Nor do we have (7) *C. peruviana*. We can well dispense with it, for HOWARD finds its bark to contain cinchonine and cinchonidine but no quinine. (8), an unknown species, we do not have and therefore cannot judge its value. (9) *C. Condaminea* in three varieties (var. *crispa*, var. *Chahuarguera*, and var. *Uritusinga*) we do not have; but particularly in times of war, *Uritusinga*, with 2% of quinine in its bark, according to HOWARD, must be considered among the best species of cinchona. Of the last four species which the British have and we do not possess, *C. Condaminea* var. *Uritusinga*

[1] Of fifty plants of *C. succirubra*, *C. micrantha*, and *C. nitida* sent from Ootacamund arriving here in October 1862, only twelve of *C. succirubra* and one of *C. nitida* lived in Java, and of the former two have since died.

is, therefore, the only one of value which we lack. On the other hand, we have in Java one species not grown in British India, *C. lanceolata* Pavon, with 1.2% of quinine. It is accepted as a good species by HOWARD, although I think it possibly only a variety of *C. Pahudiana*.

"5. *The practice followed in Java of planting cinchona trees in the shade is based on an erroneous idea.* In refuting this statement, I have made the following observations. In the cultivation of cinchona trees, I have followed the principle supported by the observations of all travellers in South America. They have announced that many species of cinchona trees grow in the shade in the high native forests; they are scattered among thousands of other kinds of trees and only here and there form small groups. To find them, the bark collectors or cascarilleros are obliged to climb the highest trees or to scale a mountain, from which at a great distance they are able to recognize the peculiar brilliancy of the young foliage which is characteristic of most cinchonas. Also the old fallen red leaves are guides wherever they are found on the ground. RUIZ and PAVON described the growth habit of cinchona trees as above. Furthermore, the vast forests wherein they are casually found have been visited by such men as VON HUMBOLDT, POEPPIG, WEDDELL, and lastly by KARSTEN in Colombia. These men have more than abundantly corroborated all earlier observations. Really tall cinchona trees with trunks two, three, and even five feet thick have been found. A single tree supplies from 60 to 80 or even to 120 arrobas (approximately 195 to 390 pounds avoirdupois) of bark, but such trees are found in the forest. Only a few stray specimens are scattered here and there in the margins of forests and from there spread over the neighboring hills or high-lying plateaus where they appear as shrubs. In this way apparently there originated the variety of *C. Calisaya* which WEDDELL named *C. Josephiana* and which now grows only as a shrub.

"When such men as SPRUCE and MARKHAM assert that cinchona trees need not be planted in the shade of forests but may be grown in regular plantations in the open sun as are the cinnamon trees of Ceylon, I must reach one of two conclusions. Either I must suppose that these men, at least MARKHAM, have been hesitant to explore the wild interior of South America and that they saw only those cinchona trees which occur as strays scattered over plateaus or growing in small groups. Or I must accept the fact that they have made concessions to natural conditions in British India. In Deccan and elsewhere in the tropically situated regions under the direct influence of the British Crown, at an altitude of 4,500 to 7,000 feet where cinchona trees grow best, they know that only fragments of the forest have been left from the ancient native cultivation of the land and the development of the coffee enterprise of the British. And, if one wishes to import cinchona, its cultivation in those regions without the shade of the forest must be proved, whether one desires it or not. Besides, I found from a printed report of MACPHERSON, at that time inspector-general of a hospital, that he had looked in vain for cinchona plantations in the vast forest in the Ghats in the Neilgherry Mountains. ANDERSON had the same experience. In his report, No. 333, to the general secretary of British India, dated February 11, 1862, he confessed the reason why he, being as much convinced as I that cinchona would grow only in the shade of forests, even ventured to go beyond the boundary of the tropics and to test his plantings in the rich woods of Sikkim near Darjeeling in the Himalaya Mountains, although the latter locality is situated 27° N. latitude and therefore apparently has a great yearly variation of temperature and offers many chances for the success of cinchona trees.

"Thus, truly scientific men have adhered to the same principle which I followed. They have recognized the fact that a wild tree, previously uncultivated, if planted in a strange land where it must be completely acclimatized, has the best chance of surviving when planted under conditions comparable to those of its native habitat; *i.e.*, when it can be planted at the same altitude, in the same average temperature, and in the shade of forests like those of the regions where it was indigenous. In the face of these facts, the writing of MARKHAM [1] means nothing, indeed less than nothing, because everywhere therein ignorance of matters pertaining to botany, meteorology, and physics is apparent.

"The method of planting cinchona trees, which I have followed, is correct in principle. In Java our procedure has demonstrated that cinchona trees which are planted on bare ground exposed to the sun will grow, even develop early, and towards the end of the fifth year begin to blossom and bear fruit; but these same trees develop a trunk no thicker than one's arm, and remain low and dwarfed like shrubs.

"The founders of the plantation at Tjibodas cut down all the forest before planting their cinchona trees. These trees are now nine years old. In addition there are many other cinchona trees in Java which I have planted experimentally since 1856, some in partial shade, others in the open. When these are compared with most of the cinchona trees growing in the shade of the forest, they provide the best evidence of the accuracy of my principle.

"I do not envy the British their cinchona plantings in the Neilgherry Mountains, which are in the open and exposed to the sun. Those trees more than five years old (if they have survived that long from cuttings and layers) should be shrubs ten to twelve feet high. At this age they begin to blossom profusely and to bear fruit, but they will not grow much taller and their trunks will not be more than the thickness of one's arm. Another thing to be considered is the expenditure. All expenses for the care of the plantings cover a period of three to five years. After that time the trees are established as shrubs in the open ground and need no further consideration. If, for example, a tree with 1.5% of quinine in the bark is grown in an open place where it has developed without protection from the sun's rays, it will never be much larger than a shrub, and the trunk below the crown will yield scarcely more than four or five pounds of bark, which will hardly defray the cost of planting. But, if a tree of the same species is planted in the shade of the forests, after five years it continues to increase in height and girth without further

[1] In addition to the already cited *Travels in Peru and India*, London 1862, comes another paper by this writer in the *Journal of the Royal Geographical Society* under the title "On the Introduction of Cinchona plants in India" in the *Pharmaceutical Journal and Transactions* Vol. IV, no. I (London, July 1, 1862; taken from the "Transactions of the Medical and Physical Society of Bombay").

cost; finally after fifteen or twenty years it will have a trunk fifty to sixty feet high and two to three feet in diameter. This, without the branches, should produce 1,500 to 2,000 pounds of bark, a fact worth remembering.[1] The largest quantity of quinine is found in the thickest bark of the trunk. The yield from the branches becomes decreasingly less toward the top of the tree until in the uppermost twigs there are no alkaloids.

"It is not definitely known whether or not the bark of a cinchona tree, grown as a shrub on a bare mountain slope and exposed to the sun, will contain as much quinine as a tree of the same species developed in the shade of the forest. French chemists have maintained that the quinine in the bark of trees exposed to the sun turns to quinidine, and KARSTEN has found a great difference in the alkaloid content of different individuals of the same species (*C. lancifolia*), according to whether they grew on a steep mountain or in a deep chasm, and were exposed or not to constant winds and the protection of clouds.

"Intelligent reasoning from all experience points to the importance of planting cinchona trees in the shade of the forest.

"Now VAN HOËVELL, on page 372 of his paper, asks: 'Are the remarks of the British writer correct? If they are, JUNGHUHN made the mistake of placing the plants in too much shade. This is evident in plants sent from Java to British India. Their appearance indicated a deficiency of light, a common fault in the Netherlands Indies. Some people try to work too much under cover; they wish to keep their actions concealed; they fear criticism. This produces many unsatisfactory results for the Government of the Netherlands Indies. That is why the worthless *C. Pahudiana* thrives luxuriantly, but the excellent *C. Calisaya* is on the decline.' In reply, I shall only observe that, in addition to too much shade, it is just as much of a mistake to place certain things in an unfair or yellow light that calls attention to them but does not give a true picture. Thus many a writer, alas, could be accused of spreading an unfair light (*i.e.* false information) regarding pioneer work in Java.

"Under the topic 'spreading of unfair light,' I mention the assertion of VAN HOËVELL on page 374 of his paper. He asks whether we are well informed that one of the large landholders of Java petitioned the government for some cuttings and seeds of cinchona plants in order to introduce cultivation to the mountainous parts of his estate, but that his request was refused. If it really happened that a landholder in Java had offered to risk his capital for an enterprise which after twenty-five years or more might begin to yield returns, his request would have been granted as willingly as the government satisfied the wishes of the British and French governments to whom they have given a considerable number of their cinchona trees. The former obtained them for Ceylon, Madras, and Sikkim, and the latter for Mauritius and Guadeloupe. But here there is no dirty work; plain instructions are given to ensure securing as good results as possible from propagation by cuttings or from seeds. I, at least, can give positive assurance that I, neither as government official charged with the care of the cinchona plantings nor as a private citizen, ever heard of such an offer from a landholder in Java. If it had happened, as intimated, I should have promoted his effort with all my power."

* * *

So far in JUNGHUHN's defense.

Let us consider the first point, namely, that *C. Pahudiana* is a worthless species since there is very little quinine in it. The succeeding results have shown that the critics, in many respects, were somewhat rash in their disapproval and in their judgment. The following comments adopted from the yearly reports of the cinchona enterprise of the government demonstrate this.

From the report for 1867: At a meeting of the Linnean Society of London, HOWARD has given very encouraging evidence, based on reports from new research and from brokers, concerning the value of the bark of *C. Pahudiana*.

From the report for 1872: The unexpectedly satisfactory returns from the sale of bark of *C. Pahudiana* of Java have resulted in the serious consideration of the question of resuming the cultivation of this species on a permanent basis. Because the pharmacist has now approved the use of this bark, other factors should not be permitted to cause its sudden removal from the market, an inevitable result if the cultivation of *C. Pahudiana* be discontinued.

In the report for 1876: The results of the offering for sale were very satisfactory and there were used

| | | |
|---|---|---|
| for | *C. succirubra* | 110 to 161 cts. p. ½ K.G |
| | *C. micrantha* | 128 to 134 |
| | *C. Pahudiana* | 110 to 168 |
| | *C. Hasskarliana* | 121 to 161 |
| | *C. Calisaya anglica* | 136 to 152 |
| | *C. Calisaya schuhkraft* | 121 to 153 |
| | *C. Calisaya javanica* | 71 to 211 |

(cts. = hundred weight)

Then MOENS said that the truth is that the bark of *C. Pahudiana* represents neither the best nor the most inferior species of cinchona. Although it is the poorest of all in alkaloid content, it is continually bought by pharmacists and its value remains comparable to other cinchona barks unsuitable for quinine preparation, even though the latter are richer in the collective alkaloids.

Moreover, the critics did not consider that one could, particularly in the first year, obtain more seeds of *C. Pahudiana* than of *C. Calisaya*, and that one took advantage of that fact as much as possible.

In the last thirty years, as cultivation progressed, chemical analysis pointed the way to the best species. Later, when seeds of better species were received from America, selective methods were used whenever possible in order to produce better material. It was not until after JUNGHUHN's work was finished that the rightly esteemed *C. Ledgeriana* Moens was imported. The reproach even lately made, that JUNGHUHN cultivated the less valuable species of cinchona, is entirely unfounded.

It would be just as unfair to blame JUNGHUHN for too greatly extending the immediate cultivation of *C. Pahudiana* as to blame his successor for promoting the cultivation of *C. Calisaya*.

Concerning the second point, namely, the practice followed in Java of planting cinchona trees in the shade of the forest, JUNGHUHN's successor commented as follows in the report on the cinchona industry of the government for 1865: A

[1] Very large mature trees produce 3,000 pounds of uncured bark.

fact already admitted and established by the British is that cinchona, especially in the experimental period of cultivation, required shade. Furthermore, one might mention at this point a planting in the full sunlight at Nagrak of a few hundred small trees of *C. Calisaya*. At the end of the first year, the plants grown from seeds were small, vigorous ones from two to three feet high. Later, with few exceptions, the bark on all these trees split open and the plants lost their vitality. This was a matter of much regret. It seemed possible to attribute it only to the heat of the sun, which shines most of the day. For this reason the plants were shaded artificially and further experiments in an entirely open terrain were abandoned. Moreover, even if the heat of the sun had absolutely nothing to do with the splitting of the bark, and even if the conclusion were reached later that shade is not desirable for the proper cultivation of the cinchona, it must not be forgotten that the period was one of experiment. It was necessary to discover under what circumstances the cinchona tree would grow best. Naturally at first one tried to cultivate it under conditions approximating as closely as possible those of its native habitat.

HASSKARL, in his letter of March 23, 1855, pointed out that, where indigenous, wild cinchona trees grew in the shade. If shade were lacking, the trees did not attain an arborescent form, but remained shrub-like. The most luxuriant growth of cinchona occurred where individual trees in earlier life were shaded by larger forest trees which in turn became overshadowed by the cinchona.

Other travellers, among them ALEXANDER VON HUMBOLDT, a competent authority, have given us information concerning the habit and habitat of cinchona trees in South America. For the most part they are scattered in groups among other species of trees, but sometimes are found standing alone. At times they are in the shade of larger forest trees, and again are found on river banks more or less in the open.

The opinion expressed by HASSKARL, in addition to the communications of a number of travellers, has also contributed to the fact that JUNGHUHN began his experiments with cinchona plants along naturalistic lines. In view of the observations of such famous research workers as RUIZ, PAVON, A. VON HUMBOLDT, and others, it would have been more than illogical, if, at this time, JUNGHUHN had not planted cinchona in the shade. That the successors of JUNGHUHN have reached another conclusion is solely the result of experiments carried out in Java and British India. A positive opinion could not be reached until after JUNGHUHN's time.

From 1856 to 1864, the management of the cinchona enterprise was entrusted to JUNGHUHN. In spite of all the difficulties which he had to overcome and the criticisms which he met, his energetic action and scientific sense kept the cinchona plantings which were only tentatively established in Java from being entirely lost.

JUNGHUHN's services as a pioneer in cinchona cultivation in Java have been outstanding, as is shown by the successful acclimatization of cinchona trees in Java. In malaria-infected regions, countless men, whose lives have been saved by the timely use of quinine, owe JUNGHUHN, as well as many others, a lasting debt of gratitude.

# Chapters in the History of Cinchona
# IV, CINCHONA CULTIVATION AFTER JUNGHUHN'S DEATH

*by*

K. W. VAN GORKOM (1835–1910), Dr. pharm. hon. c.*

*late Inspector, Govt. Cinchona Plantations, Java; late Chief Inspector for Sugar and Rice, Dept. of Agriculture, Buitenzorg; Editor "Oost-Indische Cultures"; etc.*

In the second half of 1863 JUNGHUHN began to feel himself ill. He had demanded too much from his strength, and relied on its inexhaustibility. By the beginning of 1864, his condition had become critical; a visit on furlough to the Netherlands for the restoration of his health, could no longer be deferred. This leave was granted as a matter of course by the government, and at the same time, 14 March 1864, the temporary succession of the director of the *Cinchona* culture was provided for. The nature of the malady made it necessary to return to Europe by a sailing vessel; but when the wished for opportunity of embarkation arrived, the patient was so far exhausted, that his journey was perforce delayed. The great naturalist died on the 24th April, he whose eminent abilities, unwearied and fruitful activity are fully acknowledged, although he was engaged in scientific disputes more or less all his life long. His ashes were committed to earth in a spot chosen by himself in the middle of the future *Cinchona* plantation at Lembang, and a simple pillar placed over his grave.

JUNGHUHN might well say in 1859 in poetic language: — the splendour of *Cinchona* cultivation in Java to our earthly vision can hardly be exceeded! for his risen spirit may behold the *Cinchona* forests at the present time representing millions, and ready to yield a richer reward.

The *Cinchona* plantation at Lembang was laid out in such a manner, that JUNGHUHN's grave made a point of junction with two main paths, along which at the present time are formed fine avenues. The white column may be descried from far down these; the peaceful spot at the mountain's foot, agrees well with the respect and appreciation due to him, and involuntarily cheers one to thankful remembrance of the great and gifted man, who endowed with rare knowledge and unequalled industry, and animated by inward reverence and love for Nature, investigated the geological formation and vegetable productions of Java, and in many writings of greater or lesser extent, strikingly made plain these facts to all.

* Reprinted from the author's "A Handbook of Cinchona Culture," translated by B. D. JACKSON (Amsterdam & London, 1883, pp. 69–89).

His formal resignation of the supervision of *Cinchona* culture could not take place; but his undivided devotion declared itself in the broken utterances in which JUNGHUHN committed in trust to his successors, the continuation of work begun by him.

Truly, this continuation was no easy task. However esteemed the mandate might be, the new director felt to the full the heavy responsibility laid upon him, and did not conceal his serious anxieties from the Indian government.[1]

What then was the state of things? To judge accurately of this, it is necessary to follow yet further, the history of *Cinchona* in those days. The third period of the culture is distinguished by radical divergencies from the system previously followed, and this must be explained by an exposition of the facts themselves, without in the least clouding the great services and renowned name of JUNGHUHN.

At the end of 1863 there were in the open ground:

| | |
|---|---|
| *C. Calisaya* . . . | 7,408, amongst which 5000 were *C Hasskarliana.* |
| *C. succirubra* . . | 71, of which 56 were *C. caloptera.* |
| *C. lancifolia* . . | 104. |
| *C. Pahudiana* . | 531,456, in which are included the identical *C. lanceolata.* |
| *C. micrantha* . . | 1, with 12 true *C. succirubra* received from British India in 1862. |

In the nurseries at the same time there were:

| | |
|---|---|
| *C. Calisaya* . . . | 4,685, amongst which were 4,144 so called rooted cuttings. |
| *C. succirubra* . . | 18, cuttings, all *C. caloptera.* |
| *C. lancifolia* . . | 147, do. |
| *C. Pahudiana* . | 607,920, amongst which were 55 rooted cuttings. |

Besides these, there were 208,322 seeds sown of *C. Pahudiana* which by the end of the first quarter of 1864 were compelled to be written off as bad. Further, 737 *C. Calisaya* seeds, which gave no favourable return, and about 7000 cuttings of the various species, with 6500 of *C. Calisaya*, from which little could be expected.

A marked disproportion thus prevailed between the species considered valuable, and the others which were held to be doubtful. Very little alkaloid was found in the young *C. Pahudiana* bark, and therefore relatively little quinine, but some were of opinion that the amount would augment with age, and JUNGHUHN estimated the age of exploitable *Cinchona* trees at 30 years. The future would thus it was thought bring improvement, and this suspicion based itself partly on the circumstance, that the roots of *C. Pahudiana* contained more alkaloid than the stem-bark.

On the other hand, trust in the future was precarious, and it was established as an indisputable fact, that although the *C. Calisaya* plants were of the same age as those of *C. Pahudiana*, the former were already far richer in quinine than the latter. The question could have been positively settled, or even obviated, if a careful analysis of the barks of the various descriptions brought over by HASSKARL had been made. For that purpose there was certainly old material at disposal, of *C. Pahudiana* or *C. ovata* as it was originally called.

It is certain that JUNGHUHN did not propagate *C. Pahudiana* by distinct preference, but because the first seeds, and afterwards a constant abundance, were harvested from it. Everything shows that the few *C. Calisaya* specimens at his disposal, had the greatest care devoted to them, and were valued most highly. The regulations which he devised for this purpose, seem not very happily chosen, and witness rather to his well-intentioned purpose.

Transplanting fully developed trees from the cleared grounds to the shady forests, could not conduce to flowering and fruiting. Light and air are of the first requisites for the production of blossoms and seeds.

Those trees which were too big to be transplanted remained in their original, unsheltered position, but care was taken to better their condition. A bamboo roof was provided for shelter against wind and rain, but we shall bye and bye see that this measure was not altogether a success. The trees showed considerable inclination to flower, and already in the years 1859–61, a tolerable supply of seeds was harvested, which produced about 19 *C. Calisaya* (planted at Nagrak in the forest) and quite 5000 *C. Hasskarliana.* These, at all the older establishments were planted out in the forest, and since 1864, were particularly well looked after, so that most developed into healthy trees, some of which may still be met with here and there at the present day.

Although the oldest specimens were now sheltered from wind and rain, nevertheless it acted injuriously, hindering robust growth, and the flowers did not come to development. By 1864, these were free strong plants, with thick stems and branches and well spreading crown, but bearing every token of being drawn up in vertical growth. They appeared like bushes with a short thick stem. When it is borne in mind that these few individuals, were continually being severely cut back each month to obtain cuttings, it cannot be a matter of surprise, that constant and great disappointments should take place.

The small branches and twigs which were cut off, could not possibly be called good cuttings, and this explains the fact that in spite of constantly putting-in on a large scale, no commensurate number of healthy flourishing plants were obtained. Experience of later years has amply shown, that *C. Calisaya* can only be successfully propagated by cuttings, if thrifty twigs from

[1] In June 1855 the Colonial Minister requested Professor G. J. MULDER to select a person who should be appointed by the government as chemist to the then recently introduced *Cinchona* culture in Java. The choice having fallen upon me, I considered it my duty, by order of the minister, and following out MULDER'S advice, to concern myself exclusively with quinological studies at Leyden and Utrecht in succession. In April 1856 having set out for Java, I found myself on my arrival at Batavia, effectually disappointed in my expectations. Appointed army apothecary to the large hospital at Weltevreden, I was, however, after eleven months of pharmaceutical service, nominated assistant at the Laboratory of agricultural chemistry at Buitenzorg. In September 1860 this institution was given up, and the government placed me in the Inland Board, where I remained as acting-Controller until the enactment of 31st December 1863, appointing a commission to enquire into the condition of the government coffee culture, and I was assigned as secretary to the commission. Then, when JUNGHUHN needed a substitute, the government remembered my original destination and no longer delayed entrusting to me the further conduct of *Cinchona* culture, despite the real difficulties I pleaded in the presence of the Governor-general Baron SLOET VAN DE BEELE. The provisional appointment in March, was followed by the definitive in August, and thanks to the powerful support of the government, as well as to the hearty help and coöperation of scientific men, at home and abroad, it has been my good fortune to carry on the work not without success, so that when I in my turn, in March 1875, resigned the conduct of the *Cinchona* culture, on my being nominated Chief-inspector of cultures, a candid observer might see that my devotion and endeavour to establish firmly and extend *Cinchona* culture, were not fruitless. In a scientific point of view, from the first I found especial support in my old fellow-student J. G. BERNELOT MOENS; and I have to thank his many sided knowledge and powerful coöperation for a considerable portion of the success which has been obtained.

young, strong plants are procured, or better still, healthy, fresh young shoots; even in this case good results appear greatly dependent on many factors, lying outside the general routine in the nurseries. It also seems that good and healthy roots are not put forth in every season.

At all events, the government decree of the 11th September 1862, containing the express order to suspend all further multiplication of *C. Pahudiana*, was and remains in full force. JUNGHUHN, strong in *his* convictions, had not actually adhered thereto, but in the transfer of the direction this had to be looked to in the very first place, followed by an orderly amelioration in the proportion of species to each other, — the exclusive multiplication of the more suitable, better species, and thereby make use of the lesson which disappointing experience had enforced.

Making cuttings from the oldest trees was therefore suspended, and their artificial roofing was taken away.

Several specimens of *C. lancifolia* and *C. caloptera* (at that time still booked as *C. succirubra*) which had been transplanted into the high forest on the Malawar range, were dug out with an enormous ball of earth, and brought back to their original station on open ground at Tjinieroean. All these measures were intended for nothing else than to favour the flowering and fruit setting, and they appear to have been successful in that direction. So also, with partial success, detached spirals in the manner of *ringing*, were tried on the thickest branches of the oldest *C. Calisaya* tree, and also on a *C. lancifolia* and *C. caloptera*. From the first named, a couple of hundred young plants were obtained in 1865, which were planted out at Tjinieroean, though most of them died. In 1866 the first seeds of *C. caloptera*, and in the following year, the earliest germinable seeds of *C. lancifolia* were harvested. In 1866 seven *C. Calisaya* trees at Tjinieroean were so heavily laden with fruit, that their branches bent under it.

Since that time the production of seeds has constantly augmented, so that gradually a selection could be made in accordance with the comparative analyses of the barks, to decide concerning this or that variety.

In 1867 so great a value however was still set upon the seed-crop, and so emulous were the superintendents as to their management in this, that from each careful collection, the portions obtained after cleaning, were accurately counted and parcelled out. It is well to recall these facts, for at the present time owing to the actual abundance little attention is bestowed on economy or careful treatment.

It can hardly be realised now, that long years of trouble and debate ensued, before the first seeds of a *Cinchona* tree of good quality were obtained, and these then were worth their weight in gold, and counted by tens.[2]

In the meantime the government had also made use of the help of its consular agents in South America, to provide *Cinchona* seeds, and succeeded therein, thanks to the exertions of our energetic Consul-general SCHUHKRAFT. As early as 1864, he sent a parcel of *Cinchona* capsules to the Netherlands, which by MIQUEL were determined as the produce of three varieties of *C. Calisaya*, namely, *vera*, *morada* and *Josephiana*. Half of the seeds were entrusted to the nurseries in the gardens of the Academy, the other half were sent to Java.

In the first half of 1865, about 200 plants raised from seed, were sent from the Netherlands by various means to Java, and planted out at Nagrak. Nine were planted at Lembang and probably are still there in part. In Java itself 1200 plants sprouted, which found room at the various establishments and since then have been distinguished as *Calisaya Schuhkraft*.

In the months of May and December 1868, seeds were again received from SCHUHKRAFT, from which many plants were obtained, which did not differ in appearance from the first sent. In 1873 there was again a small remittance; the dozen plants which grew from these, showed for the most part, a chestnut brown colour on the underside of the leaf, these stand in the small plantation at Tjinieroean. From yet another parcel sent in 1877, about 2000 plants were obtained, although up to the present time it does not appear that SCHUHKRAFT succeeded in procuring for us the *Calisaya* variety, which excels in its large amount of quinine.

In the beginning of 1868 seeds reached Java under the name of *C. succirubra*, sent by the Dutch Consul-general ROLDANUS at Caracas, which however I was not fortunate enough to see germinate. In 1870 from the same source came a second remittance, which was said to be derived from *C. cordifolia* var. *rotundifolia*. According to the consul's report, great quantities of bark of this species were exported, although stated to possess only one per cent of alkaloid. The seeds produced ten plants, which when developed to trees, were recognised as *C. caloptera*.

In December 1865 we came into possession of a parcel of *Calisaya* seed, from which 20,000 plants were raised, though not more than 12,000 were planted out, because at Lembang as well as the highest situated establishments Tjiwidei and Ranta-Bolang, on account of their still incomplete arrangements and capacity of propagating houses, many thousands of plants perished in their first stage of existence. We forbear speaking particularly of this sort, at this moment, which afterward became generally known as *C. Ledgeriana*, because by it, the *Cinchona* culture of the future has entered upon an entirely new phase.

Negotiations were set on foot with the directors of *Cinchona* culture in British India, at Madras, Bengal, and Ceylon in 1864 by means of the English consul at Batavia, Mr. FRASER, assuring the transmission of new valuable species of *Cinchona*, such as *C. officinalis* and *C. succirubra*, in exchange for *C. Calisaya* and *C. lancifolia*.

In 1862 there were received 12 *C. succirubra* and 1 *C. micrantha*, which were planted out in one row, along the pathway near the crater at Nagrak, and there grew into tall trees, except two *C. succirubra*, which died. In 1865 four cases of *C. officinalis* were sent from Madras; hardly a dozen plants arrived in a thoroughly healthy and fresh state at Tjinieroean, and here, after a short time of preparation, they were turned out into the open ground. From these handsome specimens, we got cuttings as quickly as possible, and it appeared that the species was propagated without difficulty by that method.

[2] This reminiscence has this confirmation: Within the last dozen years, millions of good seeds have been distributed to private speculators [illegible] in Java and else where. What has been obtained from these, is relatively paltry, and surely does not plead in favour of an always exact valuation of what is liberally bestowed.

In the course of 1865 there were further received some seeds of *C. officinalis* from Madras and Ceylon, and in 1866 another batch from Bengal, with seeds of *C. succirubra*.

Thus in truth, a new period was entered upon, and the results of the attempts to improve and increase the species of *Cinchona* considered superior to *C. Pahudiana*, surpassed our most daring expectations.

There were 100,000 plants of *C. Pahudiana* still in the nurseries, when the culture was transferred in March 1864, and these were as soon as possible planted out in the open, where, according to official reports more than half-a-million of this species already existed.

In JUNGHUHN's system, the *Cinchona* plants were distributed in the forests of the frequently mentioned mountains. They stretched over an extent of about 75 square *palen* (a square *paal* = 320 *bouws*, and each *bouw* = 7096.5 metres[3]), and any one who knows what the high, uncultivated mountain regions are, will understand that under such circumstances, subject to neither strict control, nor to a constant sufficient maintenance they were but little to boast of.

Wild beasts, falling trees and many other destructive causes, must cause the ruin of thousands upon thousands of plants, whilst moreover the natural conditions are not wholly favourable for an unobstructed development.

By 1864, the condition of cultivation permitted a rigidly accurate observation and comparison, as well as an estimate of the different influences. At a glance, only those trees were in a fresh and robust state, or growing well, which had been allowed enough space, or at least had been assured of a fair amount of direct sunlight. So also, amongst other things, here and there along the principal roads, by accident, or else by the caprice of a superintendent, some had been planted in more open spots. In seeking for the original plant-rows in the forests, many of them appeared to have wholly vanished; even where scattered *Cinchona* plants had bidden defiance to their unfavourable surroundings, they showed themselves slender, spindly, and almost branchless, and with respect to these, entirely out of proportion between vertical and horizontal development. It was evident that these tall, slender trees, could not support themselves if the surrounding growth was cleared or even if vigorously thinned. Besides, the bark of the oldest and best developed trees was as thin as paper.

There was nothing to hope for in the future from this state of things, and as to providing more light and air to the 100,000 *C. Pahudiana*, by cutting out forest trees, that, apart from the question as to whether the doubtful value of the bark would repay it, must be looked at from reasons of administrative and technical character. Therefore we confined ourselves as much as possible, to bringing under more favourable conditions, the 5000 or more trees which stood in our books as *C. Calisaya*, but have been since named *C. Hasskarliana*.

This fact was truly surprising, that just the few trees which abundantly enjoyed light and air, were seen to be most strongly developed, and that not less in the lower, than in the highest situated plantations. Wherever both conditions of existence were fully conceded, the plants appeared to develop readily into trees.

On the basis of these observations and of various economic considerations, the decree of the government of the 29th September 1864 was issued, containing the injunction: — "That no more *C. Pahudiana* plantations on a large scale shall be laid out, and the stock of plants in the nursery-beds, shall be applied only to repair and replenish." Further, "that no more labour and expense shall be devoted to existing *C. Pahudiana* plantations, than is unavoidable to prevent their total extinction."

These restrictive measures, caused by the fact that it did not appear necessary to institute experiments on so large a scale, together with the insufficiency in the first place of material for the propagation of species of good quality, led to the following changes.

The Telaga Patengan establishment was given up in 1865; the *passangrahan* Lorrok Kidoel was removed to Kawah-Tjiwidei, and the neighbouring Rantja-Bolang moved to this establishment.

Two years later the transfer of Tjibodas to the curator of the government botanical garden took place. The number of superintendents was consequently reduced from 10 to 7, and in the course of 1864, the forests were begun to be cut down systematically, from each superintendent's dwelling onwards, to make room for the plantation of *Cinchona* on the open spaces. Thus these dwellings gradually became the centres of plantations, and proportionate riper experience more and more showed, that *Cinchona*, under conditions in other respects favourable, does not require shade; on the contrary there were manifest difficulties in single forest trees being allowed to stand; so the forests were more completely cleared, only leaving strips untouched, where these might serve as protection against wind.

Having thus to deal with new species of *Cinchona*, and to plant them out under entirely fresh conditions, the method of rearing them also gradually underwent alteration.

The number of propagating houses was considerably increased, and each establishment had its own arrangements. The bamboo nursery pots, which seemed very dear, while possessing many good qualities, had also preponderating bad ones; these were laid aside, or at least the manufacture of them was stopped, and they were regularly replaced by pots of baked earth, which three Javanese at Bandoeng under our instruction, and after a little practice, very soon learned to turn out in great numbers and at very moderate cost. Previously to this, JUNGHUHN had imported several thousand flower pots from the Netherlands, but the expense was so great, that it could not be continued.

The method of germination, also underwent a radical change, under the direction of TEIJSMANN, which we shall notice when describing the cultivation.

The progress did not confine itself however to these modifications and changes. There was another question of quite as great importance, that was, the labour question. From the beginning, both at Tjibodas and Tjinieroean, all the business of *Cinchona* culture was done by paid statute-labour, and all supplies of material were ordered by the Administration. This state of things could not continue; *Cinchona* culture was not reckoned among the cultures "by the powers that be" as a consequence of the [illegible] system. By government decree of the 24th February 1864 (No. 27) it was laid down that labour in *Cinchona*

[3] This would make each *bouw* a trifle more than 1 acre, 3 poles. B. D. J.

culture merely by way of exception, might be performed by paid statute-labour, and that as a rule, permanent, voluntary workmen should be engaged for that service. The advice of the Administration as well as that of the Inspector, JUNGHUHN, had stated, that free supplies of material in the elevated cool mountain ranges, was out of the question, and still less dependence could be placed on a regular provision of the necessary voluntary workpeople. The Preanger Regencies were at that time still in an entirely special condition of proprietary and patriarchal administration; the chiefs and head men as so many great and little potentates were predominant, and the people could with difficulty form a fair idea of individual freedom, because they had never experienced it. Investigation instituted showed, that the young *Cinchona* culture in the last few years, required on an average 300 rendering statute-labour besides the permanent labourers settled upon the establishment, which were accounted for by the Inland Administration. This regime could not exist officially, though actually in force, and on the transfer of the culture in 1864, there were free supplies of materials and voluntary statute-labour still seeming to find countenance. The superintendents unanimously declared that if the system were given up, they must be dependent on the caprice of the labourers, and their belief found powerful support in the Inland Administration, so that greatly fearing a rupture of its authority and power, that body preferred to permit the continuance of the compulsion.

At the end of March 1864, after a careful inspection and complete consideration of the condition of things, I approached the heads of the Administration with the request, that they should forbid all direct interference with *Cinchona* culture on the part of their officials and chief clerks, and only to afford help when it was asked through me personally. It was emphatically impressed upon the superintendents that they would be simply removed and replaced, in case it appeared that they were wanting in the tact to provide themselves by voluntary agreements with material and labour. One helped another; during 1864 there were still many appeals for help from the administration, because the new regulations did not sit easily at first, and the population came slowly to just ideas, but little by little improvement set in, and since 1864 there has been no question of direct interference of the Administration. When in May 1865, Governor-general SLOET VAN DE BEELE came to inspect the *Cinchona* plantations, after searching interrogatory of the officials he was able to state the fact, that the government-culture had now really become a wholly free undertaking.

The above named decree also contained an emphatic recommendation, that whilst the greatest possible economy was to be observed in the culture, it was never intended that the introduction and prosecution of it should be merely a financial speculation. This recommendation was a direct consequence of the impatience which gradually showed itself in the Netherlands, where it was fancied that the results were not proportionate to the considerable sacrifices already incurred. All these together did not make the task an easy one to the new Director, and it was made still more burdensome by a stringent protest of the Administration against cutting down the forests, which had been begun as an indispensable condition to the success of the undertaking.

Hereupon followed the previously mentioned visit of the Governor, who settled the question by granting full liberty to the Director of *Cinchona* culture to go on in the way begun, and desiring the Administration to interfere no further in the operations with regard to the *Cinchona* department.

In the Dutch States-general, questions were put to the colonial Minister almost every year about the condition of the new culture, and as a rule there was no lack of complaints about its defects and slow improvement. It was not encouraging to the Director in Java, to be compelled repeatedly to protest that the development could not be forced on, that the young plants demanded time to grow into trees, and that the necessary experiments would take up many years, before all debated points were solved.

Comparisons were made with British India where *Cinchona* was introduced later, but was said to be relatively and absolutely much more forward, and further it was stated that the English had profited by the experience gained in Java, and would thus evidently incur fewer failures. On the one side complaints were made of the heavy expense which seemed to bear no fruit; on the other side dissatisfaction at the slow progress made, and whispers were not seldom heard, urging that all these costly experiments should be ended.

As to how far the complaint of "slow development" had any right to be made, or even counted as a reproach, may be learned from the official reports we have quoted; with regard to the cost, the summary of results since 1864, which we shall presently give, will speak for itself.

In the beginning of 1869, the Upper Administration expressed an explicit desire to know, whether the culture could be extended more vigorously; the opportunity for it existed in ample measure at the time, and the exports had only to do with the question as to the stocks possessed. The culture-reports and pecuniary accounts for the Upper Administration could be called satisfactory in every sense, whilst to prove that Java could already turn out produce, and that the future was far from being hazardous or hopeless, there were several hundred kilos of *Cinchona* bark harvested in 1869, and sent to the Netherlands for sale.

We must here pause for a moment to consider the following facts.

After the abandonment of the establishments Tjibodas and Telaga-Patengan, and the union of Rantja-Bolang with Kawah-Tjiwidei, there still remained seven establishments, two to the north, and five to the south of Bandoeng, which served and still serves as the residence of the Director of the culture. The many and radical changes to which the culture was necessarily subjected, made it urgently necessary that the responsible director should as much as possible himself be on the spot, where the business had to be carried on and regulated. Now it needs no argument to prove, that it was impossible to simultaneously superintend the seven outlying plantations, even with the greatest diligence and the strongest constitution. The staff of superintendents itself, was obliged to accommodate itself to the new order of things, and changes were continually taking place, so that repeatedly the guidance and teaching of

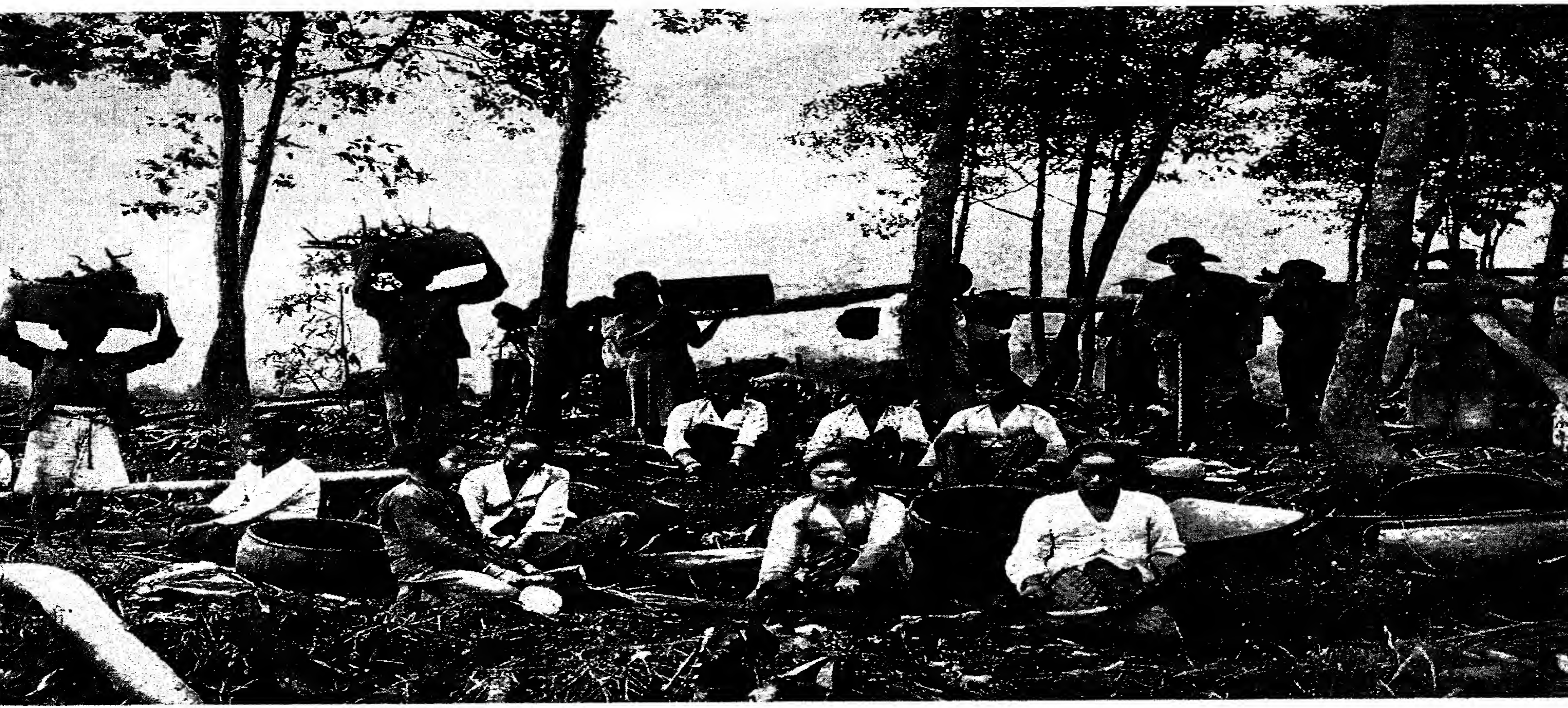

FIGURE 62. — STRIPPING CINCHONA BARK. *After* an early photograph. — *Courtesy Chronica Botanica Archives.*

novices had to be begun from the beginning. It was thus impossible that the director of the culture, although trained as a chemist, should confine himself to the laboratory, whilst the whole of his time and pains were most of all wanted in the field. On the other hand, the continued debate as to the intrinsic value of the numerous *Cinchona* barks, obliged him to be especially cautious in the choice of stock-plants for propagation, and it was about that point, in which he from the first sought as much enlightenment as possible from chemical analyses of different material. In these attempts he found his chief support in Heer I. C. BERNELOT MOENS at Weltevreden, whose help since 1865 has been incessant and disinterested.

Samples of bark were submitted to examination, from trees considered to be of good quality, which promised shortly to produce seed. If analysis proved the superiority of this or that tree, then seeds were gathered exclusively from it, and sown. Were any one at the present time to go over the analyses of those days, he would come to the conclusion that the plantations in Java had no other individuals than those yielding manufacturer's bark of the best description. Meanwhile this was by no means the case, and it must be accepted, either that *Cinchona* propagated by seed degenerates, or, that the older analyses do not show the precise value.

We shall here append a few results in elucidation of this; they deal exclusively with *C. Calisaya*, inasmuch as no other species was propagated in Java from seeds for several years after 1863.

Repeated investigations had, up to and including 1864, shown that in the barks from two of the oldest *C. Calisaya* trees at Tjibodas, there was more than 5% alkaloid, of which about four-fifths consisted of quinine and its analogues. Propagation of these trees and their descendants, was thus wholly justified according to the then scientific standpoint.

In 1868 flowering and fruit bearing trees of the false *Calisaya*, were examined which afterwards was described as *C. Hasskarliana*, and it was actually when analysed booked as *Calisaya dubia*. In the handsome bark from a tree about seven years old, raised from Javan seed, 4.960% alkaloid was found, of which 2.845% was quinine. This amount authorised its multiplication, and at Nagrak in 1870–71 there were large plantings made of this species. Another old specimen of similar age and origin gave 4.030% alkaloid, 3.320% being quinine, and a true *Calisaya* tree, obtained from the first harvested seeds at Tjibodas, and planted in the forest at Nagrak (known as No. 4) showed an amount of 4.300%, with 3.080% of quinine. A specimen of *Schuhkraft* three years old, raised from seed received in 1864, yielded 3.912% alkaloid, and 3.109% quinine (see 1868 Reports). Again in 1869 flowering trees were analysed, to see which were suitable to propagate. *C. Hasskarliana* of 7 to 8 years old gave 2.714% quinine, and one 5 year old tree from a cutting of this species, appeared to possess 6.010% alkaloid, of which 2.331% was quinine. A flowering *Calisaya* tree of 4 years old, raised in 1864–65 from Javan seed, possessed 7.483% of alkaloid, and 3.670% quinine. This little tree stood in the yard of the passangrahan at Tjinieroean and yielded an abundance of seeds which were sown without any scruple. The analyses of 1870 again confirmed the belief that we possessed and were propagating only superior kinds of *Cinchona*. In specimens of *Schuhkraft* 4 and 5 years of age there were 2.4% and 4.4% quinine found, and in a *Calisaya anglica* of 3½ years (the seed was received from Madras in the middle of 1866) 6.3% alkaloid and 3.3% quinine was met with.

Many samples were examined in 1872, MOENS then finding the average amount from 8 *Calisaya javanica* to be 1.23% quinine, 1.24% quinidine, 1.52% cinchonine and 1.01% of amorphous alkaloid. This result was not satisfactory, after we had done our best by confining our propagation only to those trees which showed a higher percentage of quinine.

MOENS calculated as average figures the following, from 8 *Calisaya Schuhkraft*, (from which during 1865–71 by far the most of the *Calisaya* plantations were obtained) 2.33% quinine, 0.43% quinidine, 0.79 cinchonine and 1.34% amorphous alkaloid. This species had then remained constant, and it might consequently be expected that the great mass of *Cinchona* bark which those plantations would produce, would turn out to be useful manufacturer's bark.

Nevertheless, experience disappointed our good expectations. Here and there samples of *Calisaya javanica*, *Calisaya Schuhkraft*, *Calisaya anglica*, also *Cinchona Hasskarliana*, were found to be rich in quinine, but taken at random, the barks of those varieties were not suitable to use for the separation of quinine.

Granting that by accident, a small part was propagated from a parent tree of inferior quality, still the fact is not explained, why the bulk of the plantations should yield barks so poor in quinine. The suspicion that actual degeneration arises from propagation, is in opposition to other experience; in each case it can be absolutely demonstrated that there is no invariable rule as to degeneration.

In the report of the chemist MOENS, appended to the official statements for 1873, he says: —

> "There is still a very important question; namely, whether there is ground for supposing that the plants which were reared from seed, will vary from the type of the parent-tree, whereby it may be feared that either the species will degenerate, in the sense that is inferior, or will possess less valuable alkaloids.
>
> "Comparison is somewhat difficult, because it may be admitted that the separate determination of each of the alkaloids, was not sufficiently accurate in all the earlier analyses, by reason of the analytical methods employed. Nevertheless facts can be shown, which are satisfactory from that point of view."

I hereby testify that in 1874 I cut out pieces of bark, and gave them to MOENS for examination, from several living trees of *Calisaya javanica*, from plantations then 7 to 8 years old, and intended in that year to be harvested in part. The results were of such a character, that we might fairly flatter ourselves that we were about to obtain from those plantations produce suitable for the preparation of quinine. When subsequently samples were taken from the entire mass as harvested and ready for market, they showed lower figures than those of the former analyses, and so we were once more disappointed. These and other facts show that there is still much that is wanting in our scientific knowledge, but at the same time they incite us to continue in methodical investigation.

Whatever was possible to throw light upon this subject, and to ensure the diffusion of plants of good quality, was done.

It is just *possible* that the parent-trees from

which seed was harvested, had come under the influence of foreign pollen, pollen that is, of inferior kinds. The strictest watchfulness cannot prevent such an eventuality, when *C. Pahudiana* occurs everywhere by thousands, and it was still more an impossibility to keep all the numerous species and varieties of *Cinchona* isolated.

The question as to the choice of sorts, by the end of the year 1872 was confined to very narrow limits. From that time it has been a fought out question; henceforth only *C. Ledgeriana*, *C. officinalis* and *C. succirubra* were to be propagated, to the exclusion of all other species and varieties. From that time also, it was possible to lay down stringent regulations, necessarily at the expense of much material, tending to prevent degeneration by crossing.

The near future will show if these regulations have hit the mark, and whether it lies in the power of the raiser to ensure a constant amount of quinine, by a rigid choice of seed.

Distinct from the question of determination of value, the chemist had still to inform us in another direction, when opportunity should serve thereto, by matured material.

We wanted to know, whether the place of growth, relative elevation above the sea, shade, or direct exposure to sunlight, kind of soil, prevailing winds, etc. can be considered to influence the formation of alkaloid.

By continued methodical analytical research, it was further to be cleared up, in which portion of the tree the most valued alkaloids accumulated, and if there were changes in quantity and quality during the different seasons as well as at various ages.

In one word; now that individuals occurred in all ages of development, of all species of *Cinchona*, at different localities and height, the chemist can and must give a helping hand to the planter, that he may help to solve Nature's enigmas. Now also had the day dawned for tracing out the best methods of harvesting and drying the bark, and for a regular, systematic examination of the parent-trees reserved for future seed supply.

In 1870 the Indian government was disposed on account of all the above detailed motives, to satisfy the urgent want of a skilful chemist to *Cinchona* culture, and in 1872 Heer J. C. BERNELOT MOENS, who had already shown himself so disinterested and serviceable was definitely appointed as such. With this gain to the culture a new period was opened up, that brought to light constantly occurring facts, and gave more positive shape and power to their further direction.

# Chapters in the History of Cinchona
# V, MODERN DEVELOPMENTS

*by*

NORMAN TAYLOR *

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Most scientific enterprises having to do with the cultivation of plants involve differences of opinion on the best procedure. After reading over the sections immediately preceding this one, it is obvious that cinchona culture suffered from the uncertainties of similar ventures. For no one then knew the cultural requirements of an admittedly difficult tree. Early struggles were far from pointing the way to final success. After years of effort and after the introduction of several hundred thousand plants and seeds from South America, it was still true, as Dr. KERBOSCH pointed out, that at the end of 1863 "the preservation of *Cinchona* from extermination had to a certain extent been attained, but it did not appear as if its cultivation in Java would prove to be an economic success." At that time there were thousands of trees ready to be harvested in Java, none of which contained anything like the amount of quinine which is today considered essential by successful planters. In other words, the tremendous efforts of JUNGHUHN, HASSKARL, and all the others mentioned in earlier sections of this account resulted in nothing of permanent value to cinchona culture in the Indies.

It is useless here to repeat the oft-told story of the introduction into Java in December, 1865 of a single pound of seed gathered by the servant of CHARLES LEDGER near the headwaters of the Rio Beni river in Bolivia. The whole episode was in the nature of a fortuitous accident, for the germination of the seedlings was looked upon with the natural skepticism generated by many attempts in the past to find a cinchona tree yielding profitable amounts of quinine. The seed was received by H. W. VAN GORKOM, then Director of the Government Cinchona Estate. Just before he died at Baarn, Holland, on March 10, 1910, he wrote: "My exertions were made lighter by experience insofar as we had learned at least not to follow in the footsteps of JUNGHUHN."

That statement reflects the uncertainty as to the previous procedure and it was fortunate that the Government Cinchona Estate was under the direction of VAN GORKOM at that time. To him, more than any other manager of the cinchona enterprise, is due the fact that *Cinchona ledgeriana* ultimately came into commercial production.

He realized the genetic instability of LEDGER's seeds and by a process of careful segregation, by isolating the plantations far enough apart to make cross pollination impossible, he was finally able to standardize high yield trees and develop the technique of their perpetuation. With him, for years, there worked a Dutch chemist, Dr. J. C. B. MOENS, who was sent to Java from Holland in 1872. As a result of thousands of analyses by MOENS, and equally scientific culture techniques devised by VAN GORKOM, *Cinchona ledgeriana* was finally ready for development under private planters. Up to this time no private planter in Java would look at *Cinchona* culture, for the

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

yield of alkaloids was too low to make it a profitable venture. All of the experimental work was therefore carried on at the Government Cinchona Estate at Tjinjiroean, Java, where they also maintained a demonstration plantation.

When the Ledger trees were old enough, bark analyses by MOENS demonstrated the fact that this species was higher in quinine content than any other tree.

Small quantities were sent to the auction at Amsterdam in 1872 and brought higher prices than any bark from Java, British India or Ceylon. It was the result of these analyses which finally interested private planters. Subsequently, they were offered planting material by the Government Cinchona Estate, and even more important, they were instructed in the technique of growing a tree that has rather special cultural requirements. It was, for instance, obvious that *Cinchona ledgeriana* would not grow on its own roots unless it had virgin forest humus. Grown, as it must be in Java, in land which often lacked these conditions, *Cinchona ledgeriana* grows rather indifferently. A still more unfortunate result of growing it in these unfavorable sites is that the quinine content is also considerably reduced.

To overcome this difficulty there was finally devised a technique of grafting young high-yielding cions of *C. ledgeriana* on under-stocks of *Cinchona succirubra*. At the present time practically all factory bark used for the extraction of quinine comes from these grafted plants. *Cinchona succirubra*, in addition to being grown for grafting stock, is also grown for the production of pharmaceutical bark in which the proportion of quinine is less. However, the presence of other alkaloids like quinidine, cinchonine and cinchonidine, makes it a valuable tree. At the present time these two species, and a few hybrids, comprise practically all the *Cinchona* grown in Java. Practically all the older species were either harvested off, or cut down, and their propagation is forbidden, — to protect the industry from cross-pollinated and probably inferior stock.

VAN GORKOM and his successors also arranged for the production of seed of *Cinchona ledgeriana* derived from so-called mother trees which are chosen not only for yield of quinine, but for horticultural qualities such as thrifty growth, thickness of bark and other qualities. Few private planters bother to maintain a seed supply of their own because the Government Cinchona Estate has ever since supplied seed of high purity, about 97% germination, and at a reasonable price. Perhaps only a geneticist will understand the difficulties of maintaining such a seed supply over a long period of years.

Very careful experiments were carried out at the Cinchona Estate to determine the best cultural methods in open plantations. This involves an elaborate system of terraces so constructed as to hold water, but allow its percolation, to prevent erosion, and by following contours, allow for the maximum number of trees per acre. Similarly, careful work was done to determine the best method of harvesting the bark. Two or three different systems were finally rejected because they were scientifically unsound and economically impossible. The present method involves the complete destruction of the tree in order to harvest the bark.

Such a system of harvesting requires that a planter must keep a succession of trees ranging from the seedbed to the final harvest. This, on most plantations, comes somewhere about the 15th to the 18th year. While there is a loss of alkaloid in waiting so long, the amount and thickness of bark more than compensate for this loss.

From the initiation of private planting soon after 1878 down to the present time, there have been many ups and downs, some of them horticultural, but mostly economic. Before the invasion of Java by the Japanese, there were 110 private cinchona estates, their combined area being approximately 17,000 hectares (42,000 acres). If all of this area were covered by trees ready for harvest it would mean something over 56 million trees. There is, however, no way of estimating the actual number of trees ready to harvest because each plantation, on account of the successional nature of the enterprise, has plants in all stages of growth.

From the beginning of private planting down to about 1893, the planters produced as much bark as they thought could be disposed of in the open market. Factors quite outside their control resulted in depressing the price of bark to such a point that they faced ruin, and the total extinction of cinchona growing was threatened. In order to relieve this situation they petitioned the Government of the Netherlands Indies for permission, and there was finally built at Bandoeng a quinine factory which assured a reasonable outlet for at least some of the bark. For their own protection the planters established a Cinchona Planters' Association in order to be in a better position to bargain not only with the Bandoeng factory but with the European manufacturers of quinine. In spite of the association of growers, the condition of the bark market from 1906 to 1912 was still somewhat chaotic, for there was in existence a similar association of quinine manufacturers. The interests of one were often in conflict with those of the other and a chart of bark prices during this period reveals the fact that the planters were often in an economically precarious position. It was, on the one hand, impossible for them to gauge the world demand for bark, particularly as no one could foresee when waves of malaria might greatly increase the demand. If such a contingency arose and it happened to coincide with a shortage of bark, there was the great danger that the world would not have enough quinine to combat that epidemic. This uncertainty led to the establishment of the cinchona agreement in 1913 which provided for coöperation between the planters and the manufacturers. Ever since, this agreement has been under the management of the Kina Bureau. This bureau consists of an equal number of representatives of the planters and the manufacturers to which is added one member who has neither to do with growing cinchona nor manufacturing quinine. The Kina Bureau has revised the original cinchona agreement in 1918, 1924, 1929 and in 1938. In the course of the years it has accumulated a tremendous store of information available both to the planters and the manufacturers, having to do with the world demand for quinine, the amount of bark necessary to supply this and many other details of technical value both to the manufacturers and the planters. Their problem has not been simple for they must provide machinery for adequate compensation to the planters for barks having varying amounts of quinine depending upon the skill of the different planters. They must also take note of the ability

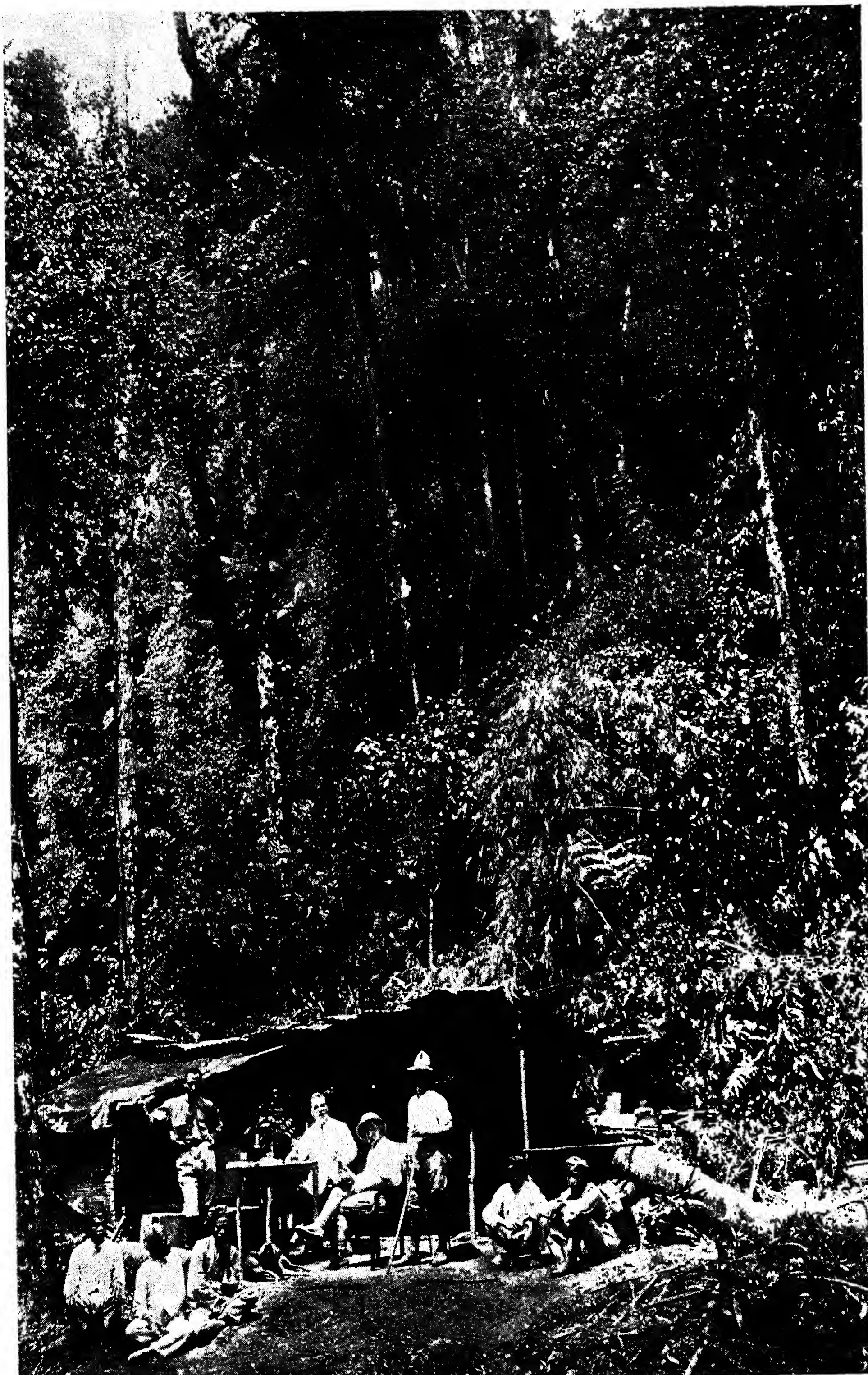

FIGURE 63. — A CAMP OF CINCHONA PROSPECTORS, WEST JAVA. — *Courtesy Neth. Information Bureau, New York City.*

of the manufacturers to extract the utmost amount of quinine from the available bark.

Much criticism has been levelled at the Kina Bureau, mostly by people who are not well informed as to the modern complexities of the whole cinchona-quinine enterprise. Their constant aim has been to keep the world supplied with quinine and to see that the planters get adequate returns. The bureau also has many other functions besides the immediate interests of the planters or manufacturers. The bureau soon recognized that there was much still to learn about the action of quinine and the possible utilization of it in diseases other than malaria. As in any other product having to do with public health, there is need for research to explore these horizons. This led the bureau to establish the Cinchona Instituut at Amsterdam and the Cinchona Products Institute in New York, both of them nonprofit organizations devoted to research and education. The support of such institutions was provided for by deducting from the profits of the manufacturers and the planters, sufficient funds to carry on the work of these institutes. They realize that the future of the industry demands scientific research. This has been actively carried on both from Amsterdam and New York. In the latter case grants for research on the cinchona alkaloids have been made to Cornell University Medical School, New York University Medical School, Johns Hopkins University, Princeton University, Columbia University, the Battelle Memorial Institute, the Mississippi State Board of Health, the South Carolina State Board of Health and to several private investigators. A similar program has been carr'ed on among European institutions and investigators from Amsterdam. Both these institutes have also carried on educational campaigns with the departments of public health in nearly every country in the world where the malaria hazard is serious. The institute in New York particularly concerns itself with the malaria problems in tropical regions of North America and the West Indies. Branch offices are maintained in Mexico and in Brazil with the same object in view.

Since the establishment of the Kina Bureau in 1913 the industry has thus been under the direction of a group of experts who have attempted to carry out a dual program. No individual planter and no manufacturer could have accumulated sufficient data to ensure the smooth functioning of quinine production. Nor could either group, or any individual, sponsor a long-time research program such as that now provided for by the bureau. It has done both and as far as any human undertaking can, protected the planters from the manufacturers and the manufacturers from the planters and provided the only known machinery for ensuring to the world an adequate and lasting supply of quinine.

Their operations over a period of years have not escaped the censure of those who think that the price of quinine is too high and especially of those who imply that perhaps quinine ought to be free to economically impoverished people. The economic impossibility of the latter suggestion is obvious, particularly having regard to the long years of experiments in Java, the deferred nature of the harvest to any one planter and the expense of quinine extraction to the manufacturers.

Recognizing the fact, however, that many people could not afford to buy quinine, the Chairman of the Kina Bureau offered to the Secretary General of the League of Nations in 1929: "the delivery of quinine for a period of many years, of the entire production of the organization after deducting its own sales, at a price that was considerably lower than the quinine price valid at that time, on the condition that the governments concerned would use this quinine, also after the expiration of the contracts, exclusively for the quininization of their own malaria regions. For the years 1931 and 1932 the quantity deliverable under this offer was estimated at 500,000 kilograms of quinine sulfate annually. This letter was answered with an acknowledgment of its receipt, but the offer has not been entered into to the present day."

In spite of this offer and in spite of the fact that quinine has been given outright to impoverished governments such as China, Greece, Brazil and Albania, there still remain those who are critical of the operations of the Kina Bureau. Perhaps the most exhaustive report on this came as the result of the appointment by the People's Council (The legislative body of the Netherlands Indies) of a Study Committee created by Government Decree No. 21, dated July 23, 1935. Their main object was to investigate the effect of the cinchona agreement and to examine how these measures and the existing organization require amendment or improvement in order to foster a greater sale of cinchona bark. The Director of Economic Affairs of the Indies, appointed Mr. A. C. VAN DEN BYLLAARDT as Secretary of the Committee which comprised in addition, eleven members, of which Dr. M. G. J. M. KERBOSCH was the President. The report reveals the interesting fact that the acreage devoted to *Cinchona* is less now than it was formerly, but that production, due to the increasing efficiency of the planters, has increased. The committee started with an apparent bias based upon the assumption that bark production and quinine manufacture had perhaps been operated too exclusively with only a profit motive. They recognized that quinine is a world necessity which, without adequate compensation to the planters and manufacturers, might easily become unavailable. They studied critically and on the spot, the operations of the cinchona agreement and could finally see no alternative but to utilize the machinery which the Kina Bureau had built up. The question arose in their minds of whether governmental interference by the Indies had better be substituted for the long experience and admittedly scientific management of the Kina Bureau. Their final conclusion, however, was that due to the nature of the deferred harvest and of the long range plans necessary to provide future supplies of quinine, it seemed unnecessary to transfer from the Kina Bureau to the Government, the regulatory powers necessary to maintain lasting supplies of quinine. In other words, the necessity for control of some sort is obvious in order to avoid the disaster of a single planter or group of them unloading all their bark at one time for the sake of a temporarily favorable market, the result of which in a few years would have been an inadequate or perhaps even a vanishing supply of bark.

A study of their report reveals that they made specific recommendations having in mind the good of the planter, the needs of the native population of Java and the obligation of the Netherlands Indies to provide the world with adequate supplies of bark and hence quinine. Their specific

conclusions (announced in 1937) are in part as follows:

(a) The necessity of collaboration between bark producers and quinine manufacturers should be maintained.
(b) A new cinchona agreement should be concluded for a definite period of at least 10 years.
(c) The system of the cinchona agreement should be maintained.
(d) The existing selling organization is considered efficient.
(e) The now valid official pr'ce of quinine is not too high. A slight rise or decline of this price will have no influence on the retail price.

*Cinchona* culture in Java has come a long way from the indiscriminate slashing of quina trees in the forests of the Amazonian Andes. For more than two hundred years ruthless and quite reckless cutting threatened the only source of quinine known to the world.

To guard against that disaster the first tentative efforts at cultivation seem now a pitiful and ineffectual gesture. But persistence, skill, and scientific coordination of plant scientists, chemists, geneticists, manufacturers and soil scientists has transformed experimental procedures into a highly organized and productive industry. Not the least satisfaction in such an enterprise is that this welding of modern science and native skills, produces a world remedy perhaps procurable in no other way.

# Chapters in the History of Chemistry in the Netherlands Indies

# I, HALF A CENTURY OF PHYTOCHEMICAL RESEARCH[1]

*by*

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On August 18, 1888, by Government Decree No. 31, the Military Dispenser Dr. M. GRESHOFF was assigned for the duration of one year to the Director of the Botanical Gardens at Buitenzorg for the purpose of instituting a chemico-pharmacological investigation into the vegetable substances of the Netherlands Indies, more specifically with reference to their medical significance. It was with this pharmacologist that chemical science made its appearance amongst the various branches of the natural sciences in the way this had thus far been organized at the Botanical Gardens here, and that was destined later on to spread over numerous other institutions, both governmental and private.

Although very likely TREUB for a long time past had felt that he required a chemical assistant, Mr. GRESHOFF's appointment would not have been such an easy matter had not Prof. J. F. EIJKMAN been actively engaged in the Botanical Gardens between October 1885 and February 1886.

Prof. EIJKMAN, formerly Professor of Chemistry and Pharmacology at the Tokyo University, was engaged at Buitenzorg in a preliminary phytochemical investigation in the course of which he felt attracted more specifically to those plants that might be of importance from a pharmacological and economic point of view.

His attention was directed specifically to potent medicines or poisons and vegetable pigments, at that time greatly in demand.

His investigations (1), however, which obviously could not be but very superficial, provided a great number of data that made it clear that a very great deal of natural material was available here which was only waiting to be exploited.

This preliminary investigation also caused it to be surmised that certain results were to be obtained not merely of scientific importance, but that could also be exploited for the benefit of humanity.

During Prof. Dr. M. TREUB's sojourn in Europe, shortly afterwards, he discussed the matter with Prof. Dr. H. WEFERS BETTINK, Professor of Pharmacology at the Utrecht University, and this resulted in a communication being sent by the latter, on February 20, 1888, to the Minister for the Colonies, in which it was shown:

1) that there was a constantly more urgent necessity of submitting the numerous alkaloids and other vegetable substances contained in the plants of our East Indian colonies, especially with a view to their medicinal value, to a scientific pharmacological and chemical investigation;
2) that the Botanical Gardens at Buitenzorg were the proper place where such investigations should be made, at least in so far as the preliminary phase thereof was concerned.

The above mentioned Report (2) of Prof. EIJKMAN, which appeared in print in 1887, gave considerable support to Prof. WEFERS BETTINK's official communication, so that it was not later than in August of that year that Dr. GRESHOFF was appointed.

Funds were placed at Dr. GRESHOFF's disposal, together with a servant and a coolie, and provisionally he was given an office with residential quarters in a small building behind the former building of the Bureau of Mines, where now are located the Museum and the Herbarium for Systematic Botany.

This small building, where also EIJKMAN had worked, still stands. It was but a tiny house, first occupying an area of 32, later on one of 54 sq. metres, but was fairly well furnished, considering the requirements of the period.

Obviously, with such an abundance of unknown material as was encountered by Dr. GRESHOFF, his investigations at first had to assume a merely preliminary character. Of this he writes at that time (3):

"Had we proceeded at once to work up into a monograph one single vegetable substance with reference to its importance and its relations as regards reagents, this would not have corresponded with the charge given us; even presum-

* Reprinted from the author's "Half A Century of Phytochemical Research in the Netherlands Indies" (Ann. Jard. Bot. Buitenz. 45:175-194, 1938).

[1] 57th publication of the Laboratory for Chemical Research, Buitenzorg.

ing that the laboratory, still in process of being established and with its simple equipment, had allowed of such a detailed research. Our Phytochemical knowledge of the flora of these colonies is still so incomplete that it must be regarded as urgent in the first place to enter upon a systematic investigation, simple in concept and exact in execution."

The technical examination of the Netherlands Indian vegetable substances was based upon the botanical relation of the plant material. But one could hardly speak of any actually systematic treatment. Sometimes the practical application of local medicine produced the decision; in other instances it was endeavoured to find the presence in local plants vegetable substances already discovered elsewhere; whilst the fact that certain material was available at any time always determined the conditions of the investigation.

In addition there were immediately submitted to Dr. GRESHOFF certain problems the solution of which was of directly practical significance.

Thus as early as in 1888, as Appendix II to the Annual Report of the Botanical Gardens, there appeared a summary of the results of the investigation to the alkaloid content of coca grown in Java, and, as Appendix V to the Communications from the Botanical Gardens over 1889, there appeared a "Note concerning the pigment of *Bixa Orellana* L." [2]

In November 1890 the principal results were published, as No. 7 of the "Mededeelingen uit 's Lands Plantentuin," in the "First Report on the Investigation of the Vegetable Substances of the Netherlands Indies." Upon comparing the subjects dealt with in this First Report with those still being studied in the Phytological Laboratory, one finds a remarkable correspondence.

The substances dealt with comprised carpaïne, the alkaloid from the leaves of *Carica Papaya* L., whilst a dozen or so *Leguminosae* were investigated, including *Derris elliptica* Benth., *Pachyrrhizus erosus* Urban (1), two varieties of *Crotalaria* as also *Millettia atropurpurea* Benth., and *Acacia pennata* Willd.

Furthermore it contained an investigation into alkaloid-containing *Apocynaceae*, including the genera *Rauwolfia*, *Ochrosia*, *Kopsia*, *Alstonia*, and *Tabernaemontana*.

All of which goes to prove that GRESHOFF's work satisfied the demands which he himself had posited with reference to it; namely, that it should be able to serve as a point of departure for subsequent research.

Here we may present a short description of his work on *Derris*. GRESHOFF managed to isolate "derride," probably a mixture of rotenone, dehydrorotenone, and some resinous compounds. He did not isolate rotenone, but the dehydrorotenone he probably did.

These various facts are to be explained, except by the methods pursued, by the fact that GRESHOFF worked principally with the rootbark of Derris, in which rotenone occurs in but minor quantity and where very probably it is more vitiated.

At that time the use of *Derris* was already known amongst the native population, but in scientific and agricultural circles no interest had as yet been evinced for it as an insecticide, but only as a fish poison and an arrow poison.

This lack of interest is remarkable, seeing that in Europe *Derris* had already been repeatedly referred to as an insecticide. (CHRISTY: New Commercial Plants, X, 39, Pharmacographica indica van Dymock, Warden & Hooper). GRESHOFF also found "Derride" in *Mundulea suberosa* Benth., whilst he mentioned its presence in timbo. By Government Decree of May 18, 1892, No. 2, Dr. GRESHOFF's temporary appointment as Assistant to the Director of the Botanical Gardens was rescinded in view of the fact that on account of ill-health he had to return to Europe. But by the same Decree Dr. W. G. BOORSMA, Military Dispenser 2nd Class, was appointed in his stead.

For a long time after Dr. GRESHOFF's departure the results of his work in the Botanical Gardens continued to appear in print. Dr. GRESHOFF, who meanwhile had been appointed Director of the Colonial Museum at Haarlem, had considerable opportunity for the further study of the literature, and hereof he availed himself very fully.

In discussing these publications here we have, for the purpose of obtaining a better survey, departed from their strictly chronological order (4).

In 1893 there appeared from his hand, as Mededeeling uit 's Lands Plantentuin No. X, a work entitled: "Description of poisonous and stupefying plants used in fishing, I," followed in 1900 and 1913 by the second and third volumes.

According to GRESHOFF these communications had to be regarded as an effort to transfer the research into the nature of fishing by means of stupefying plants from the region of ethnography and of botany, to that of chemistry and pharmacology.

From the very beginning GRESHOFF was greatly interested in these fish poisons, proof of which is constantly afforded in his Report. Also for comparative phytochemistry the study of fish poisons can be of considerable importance as soon as one is better acquainted with the nature of the various toxins.

The connection existing in many instances between the fish poisoning and insecticide activity of vegetable substances has renewed the interest in this monograph.

The fact that GRESHOFF did not confine himself to the plants of the Netherlands Indies only enhances the interest of this volume.

Besides by the publication of important phytochemical observations connected with systematic phytography, GRESHOFF also intended, by means of pharmacological tests, to collect data that might be of interest for the science of medicinal substances. The first volume deals with 233 plants and presents an historical survey of the use of the genus *Verbascum*.

The contents of the second volume is much more general than its title indicates, seeing that it deals not merely with plants used as fish poisoning, but also with all sorts of poisonous and strongly intoxicating plants, such as insecticides, anthelmintica, etc. This volume deals with about 347 plants; the third volume with 472 plants.

The monograph is a critical study of the literature; it contains but little work based upon his own experimentation.

In 1889 appeared, as the 25th Mededeeling

[2] Many of the botanical names used in the earlier phytochemical treatises have since been altered. The botanical nomenclature used in this Summary has been altered so as to coincide with that now in use.

uit 's Lands Plantentuin, the "Second Report of the Investigation into the vegetable Substances of the Netherlands Indies," by GRESHOFF, supplemented with communications by Dr. W. G. BOORSMA and Prof. P. C. PLUGGE who examined pharmacologically various isolated vegetable substances.

This Second Report, in addition to some more extensive investigations with reference to *Mundulea, Derris, Erythrina, Carica, Isotoma, Sarcolobus, Antiaris*, contains principally preliminary and short notes, most of them having reference to the presence of alkaloids. Crystallographical notes were added by Prof. A. W. WICHMANN.

Regular prunings from the Botanical Gardens supplied a large quantity of material for phytological investigation.

Although not any longer under the auspices of the Botanical Gardens, there appeared in 1899 the "Reports on Netherlands Indian Poisons," with an introduction by Prof. H. WEFERS BETTINK, of which a second edition appeared in 1902 and a third in 1914. The purpose of these Reports on Poisons was to establish the origin of the many poisonous substances, most of them of vegetable origin, frequently used by the native population.

Dr. BOORSMA began with working up the notes left by GRESHOFF, to serve for the composition of a further Report. Furthermore, all sorts of interesting discoveries made by GRESHOFF induced BOORSMA to resume the investigation and to extend it. Thus, amongst others, varieties of *Artocarpus* and *Apocynaceae* were examined. From the very beginning Dr. BOORSMA directed his attention more specifically to the study of the medicinal parts of various plants, such as *Euchresta Horsfieldii* Benn., the seeds of which are used in pulmonary affections.

BOORSMA's work (5) in many respects was differently orientated than that of GRESHOFF. The latter's work must be regarded on the whole as a treatment, as much as possible systematical, of the occurrence of various groups of compounds and as one of fish poisons and of some plants of economic significance. The work of the former is mainly to be subdivided into the three following groups:

1. the continuation of GRESHOFF's systematic work;
2. the study of native, Chinese, and Arabian medicinal substances;
3. the study of food substances and of consumption luxuries, and of other plants of economic importance.

In 1894 appeared in the "Mededeeling uit 's Lands Plantentuin XIII" the first report on BOORSMA's work. It describes experiments with the bark of *Plumiera acutifolia* Poir., whence plumieride was isolated; with the bark of *Scaevola frutescens* Krause, a medicine against beri-beri; with *Dioscorea hispida* Dennst., with "gadung," and with many other plants.

In the Geneeskundig Tijdschrift voor Ned.-Indië appeared in 1895 an extensive investigation into the red pigment of angkhak, imported from China: these being grains of rices tinted red through microorganisms. Two pigments were isolated, namely $\alpha$ and $\beta$ oryzaerubine.

The 18th Volume of the "Mededeelingen" (1896) contains the outcome of the continued activities of Dr. BOORSMA. Whereas in his "First Results" he dealt with some native medicines without any particular interrelation, the material of this Second Communication was worked up more systematically, whilst of various plant families several species were examined. Thus he dealt with various *Loganiaceae*, indicating the presence therein of several alkaloids and bitter substances, amongst others in *Fagraea* varieties. Also certain *Strychnos* varieties were examined, whence it became apparent that *Str. Tieute* Lesch. (leaf and wood) contained a good deal of strychnine but no brucine, and that the material of *Str. laurina* Wall. and *Str. monosperma* Miq. are devoid of alkaloids. Of the other families we may mention *Oleaceae, Bignoniaceae, Acanthaceae*, and *Scrophulariaceae*. Finally he deals with the plants that are known by the native appellation of "chinchau," including also *Cyclea peltata* H. f. et Th.

In 1898 the old and indeed very small laboratory was abandoned, and a new one, specially constructed for the purpose, was occupied, an honour rarely accorded in former days to any chemical laboratory. This building as such is still in use, though it has been extended by adding what was originally the Zoological Laboratory and by building over an open space now also part of it. Although according to modern notions the building has become somewhat antiquated, it still satisfies the requirements, provided not too much is demanded.

The year following there appeared, as the 31st "Mededeeling," a summary of the further outcome of Dr. W. G. BOORSMA's investigations into the vegetable substances of the Netherlands Indies. The first chapter deals with the research on the part of Prof. PLUGGE, whose life was cut off so tragically, and concerning whose work something will be said in Part II of this publication.

A poisonous alkaloid, lunasene, was isolated from *Lunasia amara* Blco., and also the glucoside maringine from the septi of the pomelo, both of which were studied. Kickxiine, a poisonous protein from *Kickxia arborea* Bl., a remedy against intestinal worms, was isolated. In many medicinal herbs a high content of potassium was found to be present.

The next year BOORSMA published an essay on "Philippine Arrow Poisons," in part as a sort of continuation of his work on *Lunasia*.

As "Mededeeling No. LII" appeared "Vegetable Substances IV," the first chapter of which deals with the investigation of arrow poisons sent by Dr. NIEUWENHUIS from Central Borneo, mainly prepared from bark of *Strychnos* varieties and from the latex of *Antiaris toxicaria* Lesch., that contains the very potent antiarine, and that has a highly poisonous effect upon the heart.

In various parts of *Strychnos nux vomica* L. and *Str. Tieute* Lesch. a new and but slightly poisonous alkaloid was found that was not contained in the other Strychnos varieties. Of the best known Netherlands Indian diuretica the potassium content was determined, which was found to be fairly high. Also a large number of plants were examined anew with reference to the possible presence therein of alkaloids, glucosides, bitter substances, pigments, etc., special attention being paid to the saponines.

These were encountered more specifically in the *Leguminosae, Araliaceae, Sapotaceae*, and *Verbenaceae*.

In the Geneeskundig Tijdschrift a treatise was published on the constituents of the kenari seed, with reference also to its use in improving the

digestibility of cow's milk, especially for infants. In connection with a practical problem an investigation was instituted into the question as to whether it would not be possible to prepare in this country a reliable Strophanthus preparation. To this end *Str. dichotomus* D. C. was examined, and an amorphous strophantine (?) was obtained from the seed. It was recommended, however, to import from Africa *S. Kombe* Oliv., but this turned out to be a failure.

In 1902 a beginning was made with the drawing up of a pharmacognostical description of the most usual Netherlands Indies remedies, whilst at the same time the collected material was submitted to a preliminary chemical examination. The study of the purely systematical phytochemistry, which GRESHOFF had concluded before he began his study of fish poisons, was also soon interrupted by BOORSMA who turned to the study of native medicines, which, as a matter of fact, was conformable with his charge.

To this end also an extensive investigation was made with reference to the various native remedies sold in the markets that specialize therein, more particularly in Central Java.

This systematic investigation was amplified by one on the *Myrsinaceae*. In 1905 appeared Bulletin XXI, Pharmakologische Mitteilungen II, in which data had been collected concerning 7 families; the investigation into *Lunasia costulata* Miq. was once again taken up, and it became possible to isolate therefrom 5 different alkaloids.

A derivative of cumarine was isolated from *Alyxia stellata* R. et S. in 1905, upon the request of the Association "Ooftteelt" ("Fruit Cultivation"). An investigation was instituted into the components of slightly less than a hundred fruit varieties, and 11 ash analyses were made. In 1907 a communication appeared on fragrant woods, entitled: "Über Aloëholz und andere Riechhölzer" (No. VII, Bulletin Dépt. Agric.), containing a description of the principal woods that spread an aromatic fragrance, and that are used in part for incense and in part also upon the burning of a corpse. Also the results of this preliminary chemical examination are here indicated.

The investigations into vegetable substances in general were continued. From the bark of *Mangifera indica* L. a yellow pigment (Indian yellow) was obtained in crystal form. An investigation was instituted into the tubers of *Merremia mammosa* Hall. f. ("bidara upas"), a native remedy against glycosuria; but the outcome was not very promising. Later on also various other anti-diabetes remedies were examined, but without any positive results.

The native remedies published in the Netherlands Pharmacopoeia were examined, in connection with which it may be mentioned that but very minute quantities of borneol were encountered in *Blumea balsamifera* D. C. ("sembung").

During Dr. BOORSMA's European leave in 1908 Mr. RITSEMA was put in charge of the Laboratory, but prior to this the results of the work performed recently were published in Bulletin XVI as "Pharmakologische Mitteilungen No. IV." From *Chydenanthus excelsus* Miers a crystalline saponine with a strongly haemolytic action was obtained.

Mr. RITSEMA (6) continued the investigations into mangiferine and the above mentioned saponine, and also examined the constituents of the leaf of the *Aegle Marmelos* Corr., a native remedy against foot and mouth disease, containing, amongst other things, an essential oil (with limonene) and some alkaloid substance. In the root of the *Hiptage madablota* Gaertn. 7.8% to 8% of a non-poisonous crystallizing compound was found, for which for the time being the formula $C_{10}H_8N_2O_{12}$ was fixed; upon its analysis there appeared amongst other substances, also Prussic acid and ammonia. Upon his return from European leave Dr. BOORSMA continued his activities.

An effort to isolate the poisonous substance of *Aleurites trisperma* Blco. remained futile; the oil, rapidly forming crystals when exposed to the air, was put aside for later examination; the seeds were found to be nonpoisonous to fowl.

An investigation was made into the preparation and the composition of agar-agar. In addition to various toxicological investigations a beginning was made with the determination of the alkaloid content of *Datura fastuosa* L., ("kechubung"); this content, however, is very low, the flowers containing most of it, namely 0.18%.

An investigation of the Chemical Laboratory for Agriculture was continued, *viz.* the presence of Prussic acid in plants. It was found that Prussic acid does not proceed from *Pangium* into *Loranthaceae* that are parasites thereon. Also the search after alkaloids was continued in representatives of the *Labiatae* and the *Euphorbiaceae.*

Upon comparing the "kelapa kopyor" and the "kelapa lilin" with the ordinary coconut, the last named was found to contain a fat with diverging properties ("Teysmannia"). A practicably usable tannin (35%–45%) was found to be contained in the fruit rinds of the "jilawe," a *Terminalia* variety. Various medicinal substances were examined, including also *Phaseolus Mungo* L. ("kachang hiju") which is used in beri-beri. Several collections were despatched, including a large quantity of latex from the greatly feared *Antiaris toxicaria* Lesch., a poisonous tree.

Also the presence of silicic acid in plants was the subject of various investigations. It was endeavoured to elucidate the origination of "sinkara" (deposits of silicic acid in bamboo); in various plant varieties with hard leaves a high silicic acid content was found.

In certain *Diospyros* varieties a vesicant substance was found; a closer investigation into the poisonous components of *Phyllanthus acidus* Skeels remained fruitless.

New experiments were made in connection with the possible preparation from kenari seeds of a milk product with keeping qualities, to be used as an infant food: these were published later on in the Indian Medical Gazette.

In Teysmannia a communication was published concerning the juice of the "reunghas"; and another, concerning "daon duduk" (*Desmodium triquetrum* D. C.), in the Tijdschrift voor Inlandsche Geneeskundigen. One of the constituents of "obat seriawan," the leaf of *Coleus amboinicus* Lour., was examined, and a fair quantity of potassium was found, together with a volatile oil. It was pointed out that it was often confused with *Bidens pilosa* L.

The following food substances and consumption luxuries were examined: seed kernels of *Elateriospermum Tapos* Bl. ("biji tapus") and *Mangifera caesia* Jack ("komang"). The first

mentioned material was free from Prussic acid, but later on poisonous seeds were received.

From various *Loranthaceae* a yellow crystalline pigment was separated, which was laid aside for examination in Europe. In the seeds of *Artocarpus elastica* Reinw. 11% of solid fat was found to be present.

More specifically for distribution at the International Pharmaceutical Congress at the Hague in 1913, an illustrated booklet was compiled, entitled: "Notes concerning the oriental medicinal applications in Java." It contains a description of the manner in which the medicinal substances are sold, whilst more specifically the various simplicia are being discussed. Though dealing mainly with the native medicines of this Archipelago, the Chinese, Arabian, and Japanese are also dealt with. In Teysmannia an article appeared on the soiling, in the course of trade, of *Cuminum* L., and one concerning the chemical composition of the thornless cactus, *Opuntia* spec., and its value as a food substance.

An analysis was made of the tiny fruits of the *Panicum viride* L. var. *β italica* ("jawawut").

Various samples of arak medicine were examined as to the presence therein of methylated spirits.

A number of opium substitutes were received for examination, including also *Cannabis* material which, however, lacked the typical resin glands of *Cannabis indica* L. used for making hashish. This investigation was continued later, the outcome being summarized in a note published in the Annual Report over 1915.

Root and stalk tubers of two *Dioscorea* varieties, namely "jebubug basu" and "j. endog," not closer determined, were examined as to their food value. They were not found to contain any alkaloids, although a red pigment was present.

The seed of *Ximenia americana* L. was found to contain 67.5% of fatty oil which still remains unused in this Archipelago.

In the seeds of *Strychnos ligustrina* Bl. from Timor 2.3% of alkaloid was found; the quantity available for export was estimated at 1200 kg. per annum.

In the essential oil of the red sandalwood of British India, *Pterocarpus santalina* L., of *P. indicus* Willd. ("angsana"), and of *Gonystylus Miquelianus* T. et B. ("kayu garu"), one and the same substance (santalol) was discovered.

An investigation was made into the identity of the "bidara laut" used in the Netherlands Indies. This is mainly the wood of various *Strychnos* varieties; but also the wood of *Eurycoma*, *Samadera indica* Gaertn., *Brucea sumatrana* Roxb., and *Alstonia scholaris* R. Br., was found to be regarded as such.

An investigation was instituted into the banana wax that is used in the batik industry and which is of interest also to countries outside the Netherlands Indies. This is won principally in the neighbourhood of Tjilatjap; several varieties were planted at Buitenzorg and compared as to their wax content. The highest yield per leaf of banana wax was 1.4 g., the melting points of the wax varieties lying between 80° and 85° C.

The plant of which the "kaju timur" originates was found to be the *Grenia orbiculata* Rottl. of Timor. The bark had a tannin content of 24.9%. In the commercial product the tannin content varied between 10% and 35%.

Dr. BOORSMA in those years was occupied almost exclusively with activities at the Agricultural College. In 1917 he was appointed Director of that institution. Dr. K. GORTER was appointed as his successor here, assuming his duties in September of that year. Besides the continuation of the systematic work, though on but a minor scale, the work of Dr. GORTER differed entirely in principle. Whereas his predecessors had confined themselves to the "first phase" of the investigation, Dr. GORTER (7) went beyond that, and determined as far as was possible also the chemical structure of the compounds which he managed to isolate.

An investigation was instituted into the poisonous substances contained in the roasted seed of *Crotalaria striata* D. C., which was used as a coffee substitute; it was found to contain a very poisonous alkaloid (sp. 217°) which is practically not decomposed through roasting. It occurs in the leaf. But it could not be indicated for *Cr. usaramoensis* Baker f. It is generally known that several Crotalaria varieties are poisonous.

In view of the assumed aphrodisiac action of *Hiptage madablota* Gaertn. a planting had been laid out hereof. Already at an earlier stage a crystalline compound had been obtained from the rind of the root, and this was now found to consist of a nitrogenous glucoside, the hiptagine: this, however, is no aphrodisiac. The bark of the twig also contains this compound, but the leaf does not. A lecture was held before the First Netherlands Indian Science Congress concerning the interpretation of the origin of this substance. It was assumed that the plant reduced nitrates from the soil to hydroxylamine which was supposed to condense with carbonyl compounds that originate during the carbon assimilation.

From *Hyptis pectinata* Poit. the crystallized bitter substance was isolated and studied in detail.

The investigation into laurotetanine, the poisonous alkaloid from the bark of *Litsea Cubeba* Pers., was continued.

The alkaloid from *Crinum asiaticum* L., the lycorine, already isolated at the time by GRESHOFF, proved to be identical with narcissine; this time it was found also in *Eucharis grandiflora* Planch. & Link. The investigation of this alkaloid was continued, seeing that it belongs to the very important pharmacological group of the hydrastine; also its distribution was traced in the *Amaryllidaceae*.

From the seeds of *Kopsia flavida* Bl. and *K. arborea* Bl. two important pharmacological alkaloids were isolated, one of which was recognized as a protoplasma poison.

The investigation concerning the presence of lycorine in the *Amaryllidaceae* was continued at the hand of the literature. It was found to be present in *Clivia miniata* Regel, *Amaryllis Belladonna* L., *Sprekelia formosissima* Herb., *Cooperia Drummondii* Herb., and *Cyrtanthus pallidus* Sims.

An investigation was inaugurated concerning the presence of glucosides in tropical plants according to BOURQUELOT, in the course of which the significance was pointed out of the glucoside-splitting enzymes.

Further work was done with cerberine from the seeds of *Cerbera Manghas* L., and the thevetine from those of *Thevetia neriifolia* Juss. A beginning was made with the examination of the *Cleaceae*. The investigation formerly begun in connection with mangiferine was published.

On June 30, 1921, Dr. GORTER died. In December of that year Dr. A. J. ULTÉE was appointed in his stead. He also began to broach an entirely new field of investigation, namely the study of the latex in tropical plants. A classification was made based upon the main substances thereof.

Data on the wax-containing latex of *Ficus fulva* Reinw. and *F. alba* Reinw., as also on that contained in the juice of *Fagraea* fruits, had already been published in the Bulletin (8).

Some latexes contain a great deal of protein, up to 20%. Those of *Plumiera acuminata* Ait., *Ficus glomerata* Roxb., and *F. procera* Reinw., *Artocarpus elastica* Reinw., and *A. communis* Forst., were found to contain many phytosterols.

In addition it was found that lanthosterol from *Fagara Rhetsa* Roxb. is identical with lupeol.

Of various *Alpinia* varieties the essential oils were distilled out and examined; out of *Celtis cinnamomea* Lindl. a large quantity of skatol was isolated.

When in March 1923 Dr. ULTÉE left, the Laboratory was temporarily closed, for reasons of economy.

It was opened again in 1929, when Dr. D. R. KOOLHAAS was appointed as phytochemist, whereupon the activities could be continued in June. A beginning was made with the examination of Netherlands Indies *Taraktogenos* and *Hydnocarpus* varieties. The outcome of the investigation of the fat of *T. heterophylla* v. Slooten, which was distinguished by a high melting point and great stability, was published (9); the investigation of *Hydnocarpus Setumpel* v. Slooten and *Taraktogenos polypetala* v. Slooten could not be concluded owing to the lack of material.

The Laboratory actively assisted in collecting material for foreign institutes.

Upon instruction issued by the Director of Agriculture, Industry and Commerce a beginning was made with the phytochemical investigation of *Orthosiphon grandiflorus* Bold., which investigation was made possible only through the cooperation of the Central Civil Hospital at Batavia. A few milligrammes of a crystalline compound were isolated, which was very strongly active as a diuretic; but in view of the exceedingly poor yield the investigation had to be discontinued for the time being.

In the roots of *Plumbago indica* L. an orange crystallized compound was encountered, the plumbagon; this was found also in the fruits of *Diospyros maritima* Bl. whence it could easily be isolated.

At Tjibodas various *Lasianthus* varieties were examined (10). It was thought that the disagreeable smell of these plants was due to the presence therein of skatol. But this proved to be incorrect; on the other hand methyl mercaptane was found, sometimes in considerable quantities, in the leaf. The varieties examined were *L. laevigatus* Bl., *L. lucidus* Bl., *L. purpureus* Bl., *L. stercorarius* Bl., and *L. bracteolatus* Miq.

An investigation (11) was instituted into the composition of the essential oil contained in the papua syrup, a soft copal from the Island of Jappen, supposed to be derived from the *Agathis alba* Foxw. This generic name, however, could not be maintained, seeing that the mother plant is really the *A. Labillardieri* Warb., which was corroborated by the phytochemical examination; this oil has an entirely different composition from that of the *A. alba* Foxw.

The essential oil of *Eryngium foetidum* L. was examined (12), and was found to contain the dodecene-(2) al-1, which compound probably plays a part in the synthesis of fat out of the assimilates.

In cooperation with Prof. W. F. DONATH an examination was made of "ragi," a Chinese yeast (13), in connection with a supposed abortive activity. This, however, could not be demonstrated, nor were any highly active chemical compounds encountered.

In cooperation with Mrs. M. BOUILLENNE (14) a method was worked out by which the physiological action of rotenone and other insecticides used in fishing could be accurately determined. Also the investigation was continued into the components of *Pachyrrhizus erosus* Urban which are actively insecticidal. *Derris* also was once again taken up for investigation. First of all a method was worked out by means of which its rotenone content could be accurately established under tropical conditions. At the same time a beginning was made with the examination of those components of these roots that are soluble in ether, as also the rotenone content of different varieties and forms.

In cooperation with Dr. K. B. BOEDIJN (15) an investigation was instituted into the presence, the method of cultivation, and the use of tea mould, a conglomerate of yeasts and bacteria which grow in sweetened tea whilst forming a considerable amount of film, thus producing a pleasing drink.

In continuation of the previous investigation made by ULTÉE various triterpene alcohols were isolated from the refuse resin of gutta from *Palaquium;* this activity was provisionally discontinued.

The examination was continued of various essential oils, namely those of a *Clausena* variety, of various Agrumen oils, of *Canangium odoratum* Baill., and of *Agathis borneensis* Warb.; the last mentioned in connection with a systematic comparison with those obtained from *A. Labillardieri* Warb.

An investigation was instituted into the pigments which are being formed in the long run in teakwood. It was established that they were oxydation products.

Assistance was rendered in the physiological investigation of Dr. F. W. WENT into root-forming substances; through his departure, however, this cooperation came to a stop.

Once again the old investigation of GRESHOFF into *Derris* was taken up. First of all a determination method was worked out for the rotenone content, which has served as a basis in the selection of the planting material, the study of the cultivation methods, the technological examination, and the entomological tests.

On January 1, 1933, the Head of the Laboratory was also charged with the management of the Analytic Laboratory; one year later the organic tie with the Botanical Gardens was broken, whilst the Phytochemical Laboratory was incorporated in a separate Section consisting of combined chemical laboratories thenceforth referred to as the Laboratory for Chemical Research of the Division of Industry of the Department of Economic Affairs.

But this has not changed the character of the Phytochemical Laboratory to any extent; it still closely cooperates with the Botanical Gardens. The scientific examination of vegetable substances still is maintained, even though its principal en-

deavour is not any longer directed towards the analysis of medicinal plants. This new combination made it possible to dispose over greater space and more apparatus, assistance, etc., whilst the analytical work, that absorbs a great deal of time, can now be performed in large measure by the Analytical Section.

Nevertheless the work was greatly delayed at first, seeing that the phytochemist was entirely absorbed by general activities. Fortunately in August 1935 Dr. TH. M. MEIJER was appointed phytochemist.

In October 1936 E. D. G. FRAHM chem. eng., and in September 1937 Dr. C. J. VAN HULSSEN were appointed specifically to assist the Advisory Commission for the Promotion of the Cultivation of Commercial Crops. Thus it became possible — and also through the appointment of analysts — to pursue vigorously the investigation into Netherlands Indian vegetable substances, and in addition to this general scientific work — which as a matter of fact was never discontinued — to discover and to study, in cooperation with other institutes and experimental stations, more specifically those vegetable subsubstances that were likely to play a part in the economic development of the Netherlands Indies.

It is hardly necessary here to present a complete survey of everything that was initiated, so that a few indications may suffice.

The activities of the Phytochemical Section are divided up between the three chemists above mentioned.

Dr. TH. M. MEIJER (16) is mainly occupied with the investigation of insecticides of vegetable origin, especially with varieties of *Derris* and *Pyrethrum*. (This research is accomplished in part in cooperation with other institutions and Government establishments, with a view to purposes of selection, with reference to which a colorimetrical determination of extracts has been worked out.) It comprises the distribution of the rotenone over the root-system; the study of the influence of external factors, such as temperature and the method of drying upon the contents of rotenone and extract; new methods of determining rotenone; the finding of other active components; and the composition of the so-called Derris-resin. In this Section also the study is pursued of medicinal herbs, more specifically of kumis kuching (17) (*Orthosiphon grandiflorus* Bold.) and temu lawak (*Curcuma xanthorrhiza* Roxb.); this research has primarily been directed to the best method of preparing these products, whilst as regards temu lawak the content of the active components, curcumine and essential oil, is being determined. A systematic examination is made of the fluctuations of these constituents in the various stages of vegetation, with reference to which it was found that both the curcumine and the essential oil contents reach their maximum within a definite period. Several varieties of temu lawak are also submitted to the same tests.

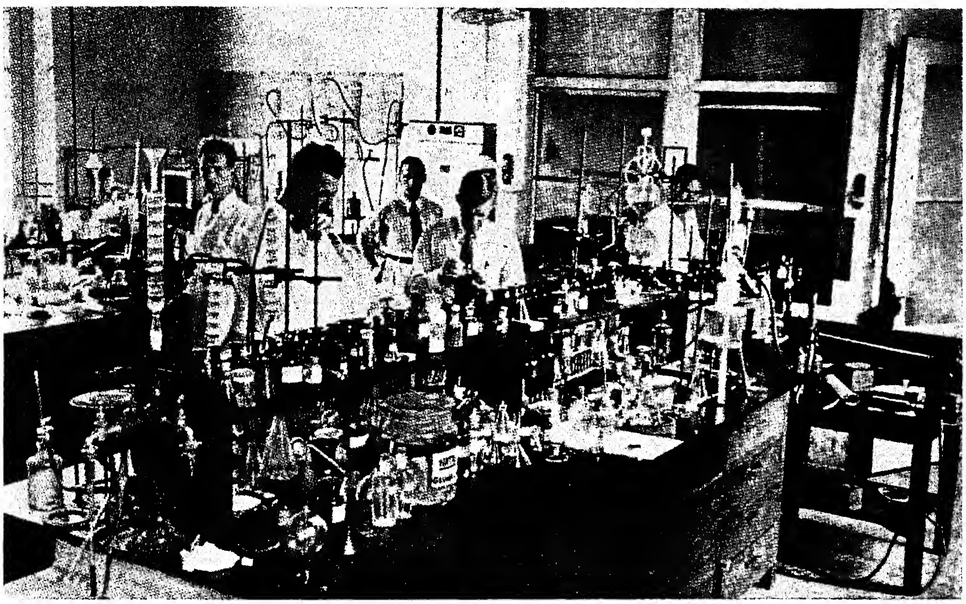

FIGURE 64. — A VIEW IN THE LABORATORY FOR CHEMICAL RESEARCH IN BUITENZORG. — *After* KOOLHAAS (Ann. Jard. Bot. Buitenz. 45).

Other subjects that have been investigated in this Section, or of which the investigation is still being pursued, are the distillation of the oil of the clove-leaf, Netherlands Indies gums of various origin, and the pigment determination of the seeds of *Bixa Orellana* L. VAN DE KOPPEL & KOOLHAAS (18) published a paper on this subject. The investigation has not as yet been concluded.

Attention was also given to various wax varieties (gondang wax, wax from *Balanophora*) and essential oil, including massooi oil, lawang oil, the preparation of shellac, etc.

For the Service of the Wildwood Forests of Java and Madoera various tests were performed on samples of different tapping of *Pinus Merkusii*

Jung. & De Vr. and *P. insularis* Endl., determining during several years their contents of moisture, turpentine, dirt, and colophonium, whilst at the same time the properties of the turpentine and the colophonium were studied. A publication on this subject was issued by KOOLHAAS & DE VOS (19).

A method was worked out for determining the activity of papaine, based upon the nephelometrical determination of the quantity of protein digested; a great many samples of papaine were tested by this method. The investigation has not yet been concluded.

The Section of which E. D. G. FRAHM is in charge (20) is equipped principally for the investigation of drying and fatty oils. In the course of an extensive investigation into the composition of the oils of *Aleurites montana* Wils. and *Aleurites trisperma* Blco. it appeared that these oils qualitatively have the same composition as has the oil of *Aleurites Fordii*, but that their quantitative composition differs considerably. In connection with the selection a new method was worked out for the determination of the quality of *Aleurites montana* Wils., of which the refractometrical determination of the elaeostearine content of these oils represents the main principle. Also a refractometrical method was worked out for the determination of the oil content of the seeds. In addition to these *Aleurites* oils, other drying oils, such as linseed oil, perilla oil, and parinarium oil, are also being investigated, whilst further considerable attention is being paid to the general examination of vegetable fats, both in the systematic-scientific sense, and in the economic sense.

Dr. C. J. VAN HULSSEN is engaged mainly with the investigation of essential oils. Various Java palmarosa oils of *Andropogon Martini* Stapf *var. Motia* were examined as to the quantity and composition of the aldehydes they contain, as compared with the British Indian oils. From the oil out of the leaf of *Litsea Cubeba* Pers. (*Litsea citrata* Bl.) various components were isolated and identified, whilst geranium oil, obtained from the leaf of *Pelargonium Radula* l'Hérit., was examined as to its various properties, being reported on favourably by the various buyers of essential oils. A beginning was made with an investigation into the composition of resin of benzoin *Styrax Benzoin* Dryand. and *Styrax paralleloneurus* Perk. It is now being endeavoured to discover a method to determine in gambir and gambir extracts their catechine extracts in addition to their tannin. An investigation is now in course of progress with reference to the determination and the properties of the mannane prepared from *Amorphophallus* varieties, whilst at the same time the application of these products is being studied.

Various other investigations are in progress, some of them already referred to in the Annual Reports of the Laboratory for Chemical Research over 1936 and 1937, which are about to be published.

We may still mention some distillation experiments with the leaf of *Pogostemon Cablin* Benth. (patchouli-leaf); the determination of the essential oil content of *Santalum album* L., and the determination of the constants of these oils.

The importance of phytochemical research in the Netherlands Indies has been regarded from different points of view. Despite the fact that already at an early date, when the first systematic attempts were made to systematize the scientific methods of research in this country, the necessity of phytochemical investigation was even then appreciated, its organization remained incoherent, and its extent very limited. Later on it became one of the first items on which to economize, as is clearly proven by the fact that this research was discontinued for seven years in succession.

Although the latest crisis at first considerably interfered with this kind of research work, later on it began to be appreciated that, in the search for new plants for cultivation and the products thereof, phytochemical research represented its keynote, for which reason it could not possibly be dispensed with. The conviction became established that amongst the plants of the Netherlands Indies there may still be very many that might play a part in the economic development of this Archipelago, whilst also amongst the plants not native here there are undoubtedly not a few that deserve to be studied somewhat more closely with a view to their development under the conditions presented here by the soil and the climate. The very considerable activity displayed by phytochemical institutes in neighbouring colonies also acted as a spur to a revision of the former attitude.

Thus it was that the results of the constantly worsening crisis actually caused the extension of the phytochemical research, in view of its proving to be an indispensable link in the labour which, in the interest of the development of the Netherlands Indies, is being accomplished in the sphere of agriculture and of technology. A broad conception of the task, such as has ever been prevailing in this Laboratory, prevents a one-sided treatment of those problems that else would be exclusively directed towards practical application, whilst at the same time it leaves adequate liberty for an integral treatment of the more systematic and basic investigations.

Thus equipped, may it be given the Phytochemical Laboratory in the years to come to assist vigorously, with the cooperation of other laboratories and institutes, here as elsewhere, in enriching our chemical knowledge of plants and of vegetable substances, and in the economic development of the Netherlands Indies.

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# Chapters in the History of Chemistry in the Netherlands Indies

# II, RESEARCHES BY VISITORS FROM ABROAD AT BUITENZORG (1884–1934)[1]

by

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The phytochemical research on the part of various visitors from abroad to the different laboratories connected with the Botanical Gardens at Buitenzorg in the nature of things was very varied, depending as it did upon the interest of the investigator.

On the one hand the interest was particularly directed to the presence and the contents of definite substances in connection with their presence in allied plant varieties. This was done, *e.g.*, in connection with taxonomic studies or with the aim of discovering important pharmaco-dynamical substances. Sometimes it referred solely to the search for chemical reactions as an aid in the study of the morphology and anatomy of the plants. Of course such investigations have a purely botanical character.

On the other hand they were chemical investigations connected with the life phenomena of plants, and therefore physiological.

According to the character of these researches they were carried out in the Visitors' (Treub) Laboratory or in the Pharmacological Laboratory, later called the Phytochemical Laboratory. Since the residence of such guests as a rule was but of short duration, their investigations were mainly preliminary, so that the results obtained must be regarded as provisional.

Now follow the names of these foreign guests who for a shorter or a longer period have engaged in phytochemical research in one of the laboratories of the abovementioned institution or of other institutions connected therewith. Wherever possible reference has been made to the literature containing the results of their activities here.

For the sake of completeness all the names are mentioned of such investigators of whom it is not exactly known whether during their residence at Buitenzorg they have been engaged in chemical research, but who have carried on such research later on from material they had gathered here, such as A. TSCHIRCH and J. WIESNER.

Prof. J. A. EIJKMAN (1), formerly Professor of Chemistry and Pharmacology at the Tokyo University, during his stay at Buitenzorg between October 1885 and February 1886 was engaged in a preliminary investigation of some plants present in the Botanical Gardens, which appeared to him important from a phytochemical, pharmacological, or economic point of view. He examined a great many plants with reference to their alkaloid content, whilst non-alkaloids or substances less definitely definable were separated from Brucea, Samadera, Nauclea, Melia, Sarcocephalus, Crataeva, Mangifera, etc. An interesting pigment was encountered in *Orophea chrysocarpa* Miq., and *Cyathocalyx sumatrana* Scheff., and a peculiar pigment and highly fluorescent substance in *Diospyros maritima* Bl. and *Diospyros Ebenum* Koen. Fluorescent substances were also indicated in the bark of many Rutaceae and Solanaceae, most clearly in *Aegle Marmelos* Corr. and *Solandra grandiflora* Sw. From the leaves of *Piper Betle* L. an essential oil was extracted, having the taste and the smell of the leaves. Also the fat contents and the melting point were determined of some fat samples, amongst which *Palaquium javense* Burck. Quantitative determinations were made of cocaine of the *Erythroxylon Coca* Lamk., here cultivated, and of other Erythroxylon varieties found in the Botanical Gardens. He also was engaged in making microscopic sections of certain important pharmacognostic plants, especially of such as produced balsam, resin, tannin, and essential oils. His visit was important

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also because it finally led to the establishment of the Pharmacological Laboratory.

Dr. A. TSCHIRCH (2), teacher at the Berlin University, was engaged between November 1888 and February 1889 amongst other things with the stucy of a number of medicinal and useful plants. Thus he was the first guest of the Laboratory founded in August 1888. He further studied the presence of resin in fruits and seeds during the development of the ovary, and the presence and behaviour of amylodextrin especially in the arilli of many seeds.

Although the results of these researches apparently have not been published as such, they have doubtlessly been worked up in various books and communications.

In 1890 Dr. P. VAN ROMBURGH was a guest of the Laboratory. He had been appointed Chief of the Third Section of the Botanical Gardens, which comprised the Estate Gardens and the Agricultural Chemical Laboratory. Awaiting the construction of the last named Laboratory, VAN ROMBURGH meanwhile was given the freedom of the Chemico-Pharmacological Laboratory. VAN ROMBURGH in his new function was assigned the task of the phytochemical research of new estate cultivations, except the medicinal herbs, the investigation of which was reserved for the first mentioned laboratory.

Although VAN ROMBURGH, not counting the first period of his acitivity, was not working in the Laboratory that constitutes the subject of this survey, his contributions to the phytochemical knowledge of Netherlands Indian plants were so important and the influence of his work, also through the activity of several of his pupils, was so great that it is necessary to refer to his activities. Upon the occasion of the 50 years' existence of the Chemico-Agricultural Laboratory I hope to describe this work in greater detail.

Dr. J. C. COSTERUS (3) of Amsterdam, during his stay here from February to June 1892, examined the quantity of organic substance which during the hours of the day accumulates in the leaves, and which disappears therefrom at night in various tropical plants, and also the periods of the day at which the maximum of assimilation products was attained; also the effect of an overcast sky upon this process.

Dr. P. ANEMA of Batavia in the course of June 1893 began a microchemical investigation into the seat of the alkaloids in the *Strychnos* varieties present in the Gardens. These investigations were to be continued at a later date, especially with a view to the appearance of the alkaloid substances during the process of growth.

Prof. Dr. WIESNER (4), Director of the Botanical Physiological Laboratory at Vienna, during his presence at Buitenzorg from November 1893 to February 1894 was primarily engaged in an investigation concerning the relation existing between the chemical intensity of light, and the form and development of plants in the tropics, pursuant to his former photometrical research. As his bases he used determinations of the chemical intensity of daylight at various hours of the day, with the aid of the Bunsen-Roscoe method. These determinations were performed in cooperation with Dr. FIGDOR.

Prof. Dr. V. A. POULSEN, of Copenhagen, stayed in Buitenzorg from December 1894 to February 1895, during which period he took advantage of this occasion to become better acquainted with those plants that are of great importance pharmacognostically, as also with their products.

Dr. A. G. VORDERMAN (5), Inspector of the Civil Medical Service, used the Laboratory in April and in November 1896, each time during one week for the purpose of a microscopical and microchemical examination of rice and maize varieties, whilst he also investigated *Pangium edule* Reinw.

Dr. G. CLAUTRIAU (6), of the Brussels Botanical Institute, remained at Buitenzorg from September 1896 to March 1897, being engaged mainly with an investigation into the localization of the alkaloids in various plants (coffee, tea, etc.) and into the part they play in the physiology of these plants.

Prof. P. C. PLUGGE (7) of Groningen, arrived at Buitenzorg in May 1897, purposing to collect in the course of about 4 months data and material of a phytochemical and pharmacological nature. He performed his work mainly in the Pharmacological Laboratory, but died a few weeks after arrival.

Prior to this there had already been established between Prof. PLUGGE and the Laboratory a close cooperation. Various vegetable substances isolated at Buitenzorg had been sent to Groningen, there to be examined by PLUGGE chemically and pharmacologically. In view of this cooperation a great deal had been expected of his visit to the Netherlands Indies.

Prof. H. MOLISCH (8) of Prague, during his stay here between November 1897 and January 1898, made investigations concerning the preparation of indigo as viewed from the standpoint of plant physiology; macrochemical and microchemical investigations into a newly discovered plant containing cumarine (*Ageratum conyzoides* L.); a newly discovered plant containing indigo (*Echites religiosa* T. & B.); cells containing cystolites in *Acanthaceae* and *Urticaceae*.

Dr. M. RACIBORSKI (9), of the Kagok Experimental Station at Tegal, in March 1898 examined a great number of various plants with reference to the presence therein of leptomine.

Dr. A. PREYER (10), of Berlin, remained in Buitenzorg from January to November 1900, his purpose being mainly to become more familiar with tropical estate products and their cultivation. Also he did research work connected with the fermentation of cocoa, with the anatomy and practical value of the bark fibres of *Urticaceae*, the preparation of ramie fibres, rational methods of tapping caoutchouc latex, the fermentation of coffee, the practical value of certain resins, the preparation of cananga oil, and the investigation into certain ferments that occurred in fermenting fruits.

Dr. W. BUSSE of Berlin stayed here from October 1902 to February 1903, during which period he studied certain chemicophysiological processes that make their appearance during the drying of cloves.

Dr. TH. WEEVERS (11), during his stay in 1902–1903, worked in the Chemico-Agricultural Laboratory on an investigation into the physiological significance of caffeïne and theobromine.

The Military Pharmacist K. HOLTAPPEL from November 1910 to March 1911 worked as our guest, his aim being to specialize in specifically Netherlands Indian pharmaceutical subjects. Also Dr. P. H. WIRTH (12) towards the end of 1911 worked here during several months with the same end in view.

Dr. J. NAUEN, of the Höchster Farbwerke, during February 1913 worked here on his researches on the origination of indigo in the *Indigofera*.

Prof. Dr. E. GOLDSTEIN, of the Berlin University, in 1913 came to the Visitors' Laboratory in connection with his researches on the effect of sunlight on certain silver salts.

Prof. Dr. KEITA SHIBATA (13), of the Tokyo University, spent several weeks (January–February 1917) in the Visitor's Laboratory, pursuing his investigations into the presence of flavone in tropical plants, having begun his research in Japan. He also made several trips across Java collecting material of estate cultivations and pharmaceutical herbs. The results of his acitvities here have not been published separately, but were embodied in one of his numerous publications on flavones in plants.

Mr. C. VAN ZIJP (14), an apothecary of Malang, in 1920 and 1921 was placed in charge of the Botanical Laboratories during Dr. F. F. C. VON FABER'S leave, in the course of which period he was engaged in various kinds of microchemical research. He examined Java beetles as to their cantharidine content, succeeding in demonstrating the presence of this substance in *Horia debyi* and *Cissites maxillosa*, causing him to publish a short article on this subject in the periodical TREUBIA.

He worked out a method for the determination of the localization of aluminum in plant fibres, and one for the application of hydrochloric benzidine as a reagent to lignified elements instead of phloroglucine.

In addition to these investigations he was collecting data and material with reference to certain *Zingiberaceae*, Chinese medicines, and various itch-resins that are of a legal interest.

In 1922 Mr.T. E. H. OBRIEN, a rubber chemist of Ceylon, was the Laboratory's guest for some weeks.

Miss MARIE REIMER (15), of New York, in 1929 investigated the effect of light upon cinnamonic acid.

Prof. Dr. R. BOUILLENNE (16), Director of the Botanical Institute at Liège, and Madame H. BOUILLENNE, remained here from April 1930 to November 1931. Prof. BOUILLENNE, in cooperation with Dr. F. W. WENT, was occupied mainly with the study of the internal and external factors affecting the root formation in plants.

Mme. BOUILLENNE (17) was chiefly concerned with investigations, in cooperation with Dr. D. R. KOOLHAAS, Chief of the Phytochemical Laboratory, concerning the toxicity of the seeds of *Pachyrrhizus* and of rotenone, the active component of the *Derris* root.

Mr. ROBERT HILL of Cambridge, during his sojourn from September 23 to October 3, 1932, made an investigation into the mengkuduk pigments (*Morinda*).

Although the Phytochemical Laboratory is no longer a part of the organization of the Botanical Gardens, its cooperation with this institution is still very close, whilst the old traditions of hospitality will be maintained.

For those who may feel attracted to the chemical investigation of Netherlands Indian plants the Laboratory at all times will gladly provide the opportunity to perform their work, in the interest of the science of phytochemistry.

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# FORESTRY IN THE OUTER PROVINCES OF THE NETHERLANDS INDIES

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When we speak of the Outer Provinces in reference to the Netherlands Indies we mean the whole of that territory except the islands of Java and Madura. The name sometimes strikes the uninitiated as strange, but a little knowledge of the outlines of Netherlands colonial history immediately makes plain that it is rooted in the facts of administrative development. In the earlier stages of Dutch contact with the Indies — during the 17th, 18th and the first part of the 19th centuries — the Netherlands Indian Government concerned itself principally with Java and Madura. Here its rule became gradually more and more intensive, while in the remaining territories the administration was long content with a sovereignty which, though very extensive, was too little elaborated to be intensively felt by the native population except in certain coastal towns and the immediate surroundings of these. During the last portion of the nineteenth century the situation gradually changed and since the beginning of the present century these Outer Provinces have been drawn within the circle of effective administration. Forestry as an integral part of the administration has, generally speaking, kept pace with the rest of the general machinery of government, and its various special activities and services.

In Java forest administration was begun on a limited scale in the middle of the 19th century, and after gradual development a regular forestry "service" was definitely organized towards the end of that century. A corresponding service was established in the Outer Provinces in 1908. In that year a special inspector of forests was appointed for these islands. Previous to that date any assistance needed in those areas had been rendered by the forest inspector of Western Java. At first the inspector for the Outer Provinces was itinerant; in 1910, the first forester in these regions was assigned a permanent station on the island of Muna, near Celebes.

Now the people in the Netherlands cannot claim to be "forestry-minded." In the mother country the general public knows little about forestry from practical experience in consequence of the fact that vast forests do not occur in the

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lowlands by the sea. Most of the timber needed is obtained from abroad. For centuries a whole fleet of freighters sailing under the Netherlands flag has carried timber from the Baltic countries and Scandinavia to Western Europe. Holland has no mountains. Hence the dangers which threaten that country are not connected with the denudation of mountain slopes; they come from another direction — from the sea and from the rivers; therefore the country has to rely for its protection, not on a forestry system to preserve its soil, but on numerous dikes to keep out both sea and fresh water. Is it any wonder, then, that forestry problems in the Indies were not among the first to receive attention in the field of colonial administration? Government officers of the earlier generations did not yet realize the importance of forest management; to them the forests were merely the source from which timber could be drawn for buildings, bridges and ships, and for export.

In the second half of the nineteenth century it became evident that the traditional ways in which the timber resources were handled left much to be desired. The teak forests in Java appeared to be threatened considerably by dangers from the prevailing system under which the natives, in the course of supplying the need for timber, were allowed to cut down the trees freely without expert supervision. As a result of these considerations a number of foresters were appointed to supervise and organize the exploitation of the teak forests. At that time Netherlanders desiring to qualify as candidates for the forestry service were obliged to go abroad for their professional training. Later on, the theoretical part of this training was made available in the Netherlands and a school of forestry was established at Wageningen, but for the practical part of their training students still have to go elsewhere, as the Netherlands, to which nature has denied the possession of large forests, offers no opportunity for the study of forest management, except on a scale that would be inadequate for men destined to hold posts in the Indies.

The forestry officers appointed in the latter half of the nineteenth century initiated the establishment of adequate management for the valuable teak forests in the lowlands of Java. Meanwhile they were thoroughly convinced of the importance of the mountain forests and of the necessity of their being preserved. As experts they soon made the administrative officers and the central government realize the necessity of establishing forest reservation all over this island. Developments along these lines were satisfactory. It appeared that the expense involved could be defrayed out of the returns gained from the teak. In a general sense the forestry service was organized and run on a self-supporting basis and, circumstances permitting, as a revenue-producing organ.

Finally a beginning was made in the Outer Provinces. The first men sent to the new territory were assigned areas where the exploiting of teak forests showed some promise of financial returns. On the island of Muna, Southeast of Celebes, where, as remarked above, the first forestry officer was stationed in 1910, there are about five thousand hectares of teak. In the course of a few years a forester was appointed for most of the residencies of the Outer Provinces. In 1912 there were two such officers; and by 1930 the number had risen to thirty. The world-wide depression necessitated retrenchment, and by 1936 the number of foresters in the Outer Provinces had been reduced to twenty, but in 1937 it rose once more to twenty-three. In 1928 the supervision of this vast territory had been put into the hands of two supervisors; in 1936 the supervision of the whole area and of the local forestry officers was entrusted to one man.

The task laid on the shoulders of these forestry pioneers was by no means light. First of all the territory in the charge of each individual forester was enormous, the area of the Outer Provinces in their entirety being roughly 176.5 million hectares. Obviously it was very difficult for a forestry officer to know where and how to begin. As a rule his first act was to make a general survey of his section of the country so as to find out what aspect of the work needed his attention most urgently in each particular district. Another difficulty was that to rely on experience in Java for guidance in the work in the Outer Provinces was useless, as conditions differ very greatly in the two regions, so that an entirely new system of forest administration had to be built up. A great number of questions required attention in the different districts. How greatly conditions vary may be illustrated by the fact that the distribution of forest lands ranges from 15 to 89 per cent of the surface area in the various administrative units. The total forest area for the Outer Provinces in their entirety is estimated at 120 million hectares, or 68 per cent of the whole extent. The density of the population in the different islands and in different parts of the same island is another factor that illustrates the prevailing diversity; and being an extremely important point with reference to the maintenance of forests, a special study has been made of various comparatively populous localities.

On the whole the islands may be said to be mountainous, which means that deforestation and subsequent erosion of the soil would spell disaster. Hence the seriousness of the fact that in certain highland areas and on the slopes of some of the volcanic peaks part of the forest lands have already disappeared as a result of the shifting cultivation of the natives who, acting on the strength of old traditions, have made numerous extensive clearings by felling or, in comparatively dry regions, burning the trees, thus sacrificing valuable timber and jungle in order to use the ground for a year or two for the purpose of growing foodstuffs. The native tribes engaged in this type of moving agriculture, which is known by the name of *ladang* cultivation, have no idea of the damage they may do to the land thus exploited. After ladang occupation the land is usually left to nature. In many cases the fertile top-soil may be washed away by erosion and what is left of deserted ladangs is often covered by alang alang, *Imperata cylindrica*, instead of trees.

In many cases this clearing of the forests on behalf of ladang cultivation in the upland areas did more than cause erosion and damage the highland country. Often the lowlands suffered too. The regular supply of water for the irrigated rice fields decreased, and sometimes floods occurred, which endangered, damaged or even destroyed roads and bridges and made agricultural lands useless — the usual inevitable consequences of deforestation known all the world over. It was not easy to find a solution to this problem, for merely to forbid the natives to

plant above a certain altitude was not sufficient. In some parts of the country settled forms of agriculture were already being carried on above the proposed limit. As a general policy the government decided to make forest reserves immediately to prevent further deforestation, leaving the problem of the areas already cleared and sometimes constituting a potential danger to the lowlands to be worked out gradually and without undue precipitation.

Besides the reserves made for hydrological reasons, there were others established to maintain the timber supply. This may seem supererogatory in view of the fact that there are at the present still 120 million hectares of forest in this country. It must not be forgotten, however, that forests are not all by any means equally important from the point of view of timber. It is a well-known fact that tropical forests are very different from those found in the temperate zones. Not only are they composed of trees different from those that abound in cooler climes, but in well-nigh all cases each forest represents a great number of species, whereas a forest in the northern hemisphere usually contains only one or at most a very few species. In the Outer Provinces it is only seldom that a comparatively large stand of the same kind of tree is found in a particular part of the jungle. In this connection we may mention that the teak forests of Java are an exception, in that they are actually composed of practically nothing but teak (*Tectona grandis*). On the other hand the far-famed teak forests of Burma and Siam are mixed forests.

The exact number of species occurring in the Netherlands Indian forests is still in the course of being determined. Probably there are between three and four thousand different kinds of trees each possessing its own specific qualities as a member of the great community of trees we call the jungle. The facts involved in the composition of the forests are very important in connection with rejuvenation thereof, and a knowledge of them is most necessary for those concerned in this work. From the point of view of direct interests the most significant fact of all is that most of these different species produce their own characteristic kind of timber and that, while some sorts of wood found in this part of the world are known to be commercially valuable, others are worth distinctly less and others, again, are considered of no use at all. This evaluation of timber is, of course, dependent on a complex group of circumstances and these may change very materially within even a short period of time.

It is a well-known fact that the forester's chief duty is to use the present timber stock to the very best possible advantage and to estimate the supply that may be counted on, not only during the next few years, but during an indefinite future. Thirty or forty years ago the solution of this problem was not considered very difficult, especially not in reference to forests in the temperate zone. But in the tropics matters are different. The tropical jungle consists of a conglomeration of trees each of which is fighting for its life, but the increment is not high. Old trees of great height prevent the development of younger ones, while their own power to grow gradually diminishes and they begin to die off and decay. But not until they have actually fallen does the new growth get a chance to develop. At the present time the amount of marketable timber to be found in these primeval forests varies very much from place to place. In some regions, where dipterocarp trees abound, 250 cubic metres may perhaps be cut per hectare, while in other regions most of the species represented are useless for sale though they may come into demand at some future period and thus acquire value from the commercial point of view. But of all these forest lands it may be said that even after everything usable has been cut out of the jungle, what is left is still a forest. In fact there are cases in which the untrained observer would not even notice the difference between the original forest and the one from which all marketable timber had been removed. The great question may be put thus: is the present growth of the saplings such as to guarantee an equal supply of timber in future years?

The best plan would be to leave standing only the young trees belonging to valuable species and to fill in open spaces by planting other useful saplings. But what species will be considered valuable many years hence? Thirty or forty years ago the forests were looked on as merely a stock of timber for general building purposes. At that time the hard woods were the only tropical varieties that were valuable and marketable; hence the forest officer aimed at regeneration with hard woods. Nowadays one is inclined to think it is better to aim at increasing the production of certain kinds of soft woods, since several *Dipterocarpaceae* and *Sapotaceae* have recently proved more easily marketable than the hard woods. These particular kinds of soft wood have the further advantage that they yield so much more quickly than the hard woods. Whereas the latter require from eighty to one hundred years to grow to marketable size, soft wood takes only fifty or sixty. But who knows what timbers will be in demand forty or fifty years hence? The forest expert has to consider the needs of the future, but no one can foretell in what directions industry will develop. If, for instance, the demand for special cellulose fibres increases, it would be advisable to grow those varieties of wood which produce the greatest amount of cellulose in the shortest possible time. Industry may, however, develop new requirements. The problem of the best way to regenerate the forests is therefore still an open question.

Though small in number, the band of pioneer foresters in the Outer Provinces of the Netherlands Indies has nevertheless made considerable headway during the period of its activity. For instance, in those regions where mountains had been previously denuded to the extent they had in certain parts of Sumatra and Celebes, the mountain forests have been completely delimited. At the end of 1936, 9.8 million hectares of forest-land had been set aside for protection and improvement. In Sumatra 15 per cent of the surface area has so far been assigned for reservation; in Borneo 2.9 per cent, and in the Moluccas 1.7 per cent. For Java the figure is 20 per cent. It is to be hoped that in the course of time this latter percentage will not only be equalled but exceeded in the case of the other islands.

Of the above-mentioned almost 10 million hectares 6.5 million have been definitely demarcated. Fifty thousand kilometres of boundary — chiefly in the form of pathways — have been delimited and measured. A total area of 30 million hectares of country have been surveyed and charted. In most cases this can be done on

the basis of existing maps and charts supplied by the topographical service. As previously stated, here and there great tracts of country were found where denudation for native agricultural purposes had been carried on to such an extent that it was necessary to include them in the forest reserve areas. Reforestation has begun on these, too, and although this has not, up to the present, been done on a very large scale, yet the total area — including afforestation tracts — on which new timber is growing was already well over 10,000 hectares at the end of 1936. On the island of Sumatra *Pinus Merkusii* has been very much used in regions where protection forests were to be planted, for the reason that these trees will eventually be valuable as sources of products such as turpentine, resin and wood. In other parts of the Archipelago teak is an important factor in reforestation.

From time immemorial the inhabitants of all the islands have been in the habit of cutting down trees — not only to supply their personal wants and for building houses, bridges and landing stages in the coastal towns — but also for export to Java and foreign markets. Exporting has always been done through the agency of middlemen, very often Chinese, who buy up the wood from the country people. Obviously the forests chosen for exploitation were those from which transport to the various markets was a comparatively simple matter. This is why at the present time we find that from the banks of the larger rivers and from easily accessible areas much wood has disappeared. As unsystematic exploitation of this kind is certainly disadvantageous, the Forestry Department has tried to limit it as much as possible. The middlemen were given an opportunity to obtain exploitation concessions of various sizes. So far not much has been achieved by this policy, for the men who took out these concessions often reverted to their old habit of buying from the natives. It appeared that, except by this inexpensive method, exploitation was economically impossible, however small the financial demands made on the holder of the concession. One such concession was equipped by a European company with every modern mechanical convenience but had to be closed down after a ten to twelve years' effort to make it pay. The capital sunk in this concern — it was in the island of Simalur, West of Sumatra — is estimated at 8,000,000 guilders. In Borneo several enterprises were established for the exploitation of hard wood. These, too, have been obliged to close down entirely or else to retrench and work on a smaller scale for the local market, or for exporting to the Netherlands.

It gradually became more and more evident that since the hard woods are not gregarious but occur at considerable intervals over large areas, it would be necessary to direct greater attention to the more plentiful soft woods and seek a market for these, not only in Europe but also in the Pacific area. In such cases the dipterocarp forests of North East Borneo would be valuable. In the course of the last few years one Netherlands and several Japanese timber enterprises were established on the East coast of Borneo.

On the East coast of Sumatra this exploitation of soft woods has been going on for decades in the peat swamp forests on the coast opposite the islands of Bengkalis and in the Riouw Archipelago. In these regions what is known as the *panglong* system is applied. This is a word borrowed from the Chinese to indicate the special type of lumber businesses in these regions. It includes both the concession area where the exploitation work is in progress and the compound of workshops, houses, shanties, etc., where the lumbermen work, live and store their products. Panglongs often produce charcoal as a by-product. The concessions are usually taken out by Chinese merchants living at Singapore; the lumbermen are imported Chinese and the timber is taken to the saw-mills in Singapore by Chinese junks. During many years preceding the world-depression, about 400,000 $m^3$ were cut annually in the panglong area. In 1933 this figure fell to 150,000 $m^3$; it has since risen and is now 200,000 $m^3$. These peat-swamp forests, which occur only in this particular region, include a comparatively limited number of species — not more than one hundred at most. Among the kinds represented are not only a large percentage of *Dipterocarpaceae* but many *Sapotaceae* and certain other useful species as well. In view of the fact that roughly 70 cubic metres of timber is obtained per acre, it is an easy matter to estimate the vastness of the area cleared, or practically cleared, in the course of 50, 60, or more years. This method of exploitation has the advantage that it leaves the young trees standing. Fortunately, it appears that rejuvenation of the forest goes on apace here and, curiously enough, the most valuable species appear to be very well represented in the new growth. This encouraging state of affairs no doubt links up with the fact that such grasses as *Imperata cylindrica* and *Saccharum spontaneum*, which might otherwise impede the development of the young saplings, cannot get a foothold in these peat swamps. Interesting researches have been made of recent years with a view to determining which forest areas may still be safely cleared and whether it is feasible to continue exploitation on the present scale. The conclusion reached was that, on the basis of a sixty-year period, for the first twenty years 4000 hectares yielding a total of 280,000 cubic metres could be cleared annually; for the second period of twenty years about 4300 hectares with a yield of roughly 300,000 $m^3$ might be counted on annually; and during the third twenty years, an average of 6400 hectares with a total yield of about 450,000 $m^3$.

It is regrettable that other kinds of forest cannot be rejuvenated in a like easy and natural manner; but such is the case. For these, other methods will have to be devised. A beginning along this line has been made in Sumatra and Banka, where schemes are being tried out to arrive at a comparatively economical way of regenerating the woodland areas with valuable trees.

Another pressing problem is how reforestation of the highlands for hydrographical purposes is to be managed within the inevitable limitations set by financial considerations. The simple method of growing saplings in nurseries and then transplanting them to the forest is quite impracticable where we are dealing with huge areas, especially when such areas are so situated that they cannot be expected to serve as timber supply as well as protective forests. What is needed for reforestation in such regions is a number of species that can be easily propagated by seed, that will grow under the conditions obtaining in

each particular area, and which will in due time produce a stand of trees adequate from a hydrographical point of view. In districts where the population is fairly dense, species which require a certain amount of work in the woods and in the process of preparing them for the market should be planted. This will help to make such areas useful to the community by providing work for many of its members.

This summary of the activities of the Forestry Service would be incomplete if we should omit to mention the efforts made by its staff to arrange for the regular supply of mine-timber and fire-wood to the collieries and gold mines of Sumatra and the tin mines in Banka. Special activities were set on foot by the forestry officers to ensure that the needs of these industries might be attended to.

Detailed statistics are beyond the scope of the present article; besides, these can be found in the annual reports of the Forestry Service. But to give the reader some idea of the amount of wood cut annually, we cannot refrain from mentioning the following facts: In the Outer Provinces 997,000 cubic metres were cut in 1936; 62% of this quantity was used for home consumption, hence only 38% was exported.

There is one other subject of importance to the Forestry Service in the Outer Provinces, namely, that of the minor forest products, which play so large a part in the lives of the villagers up-country, who are largely dependent on them as a means to cover their need for cash and for such necessaries as are obtainable for cash only. The most important of these minor forest products figuring in the export trade are rattan, resins (damar, copal, dragon's blood), camphor and certain tanning barks. For the home market the major forest product, timber, is most in demand, but for the foreign market the minor products take the lead. In 1936 the export figure for the latter was *f* 4,900,000 as against *f* 3,600,000 for the former.

In harvesting these forest products the up-country population has been found to apply in certain parts of the Archipelago careless and generally unsatisfactory methods, thereby lowering, unnecessarily, the standard of quality and causing depletion of the supply in the wooded areas near settlements. The result is that in such regions the inhabitants can obtain these forest products only from a great distance. As regards rattan — this valuable product is being planted afresh in several parts of Borneo near the villages. In the case of damar and copal, trees are sometimes tapped in such a way as to endanger the future supply. Though official supervision in this matter is extremely difficult, as the trees are found sparsely scattered over vast areas of jungle, the authorities have succeeded in establishing it in various districts, thereby preventing the trees from being damaged by over-tapping.

The forestry officers are also giving attention to the qualitative improvement of the forest products. The importance of regulating matters in regard to these products is now generally recognized. Many measures have already been drawn up in this connection; their execution being most effective when entrusted to special forestry officers.

Finally, we must not omit to mention that there exists a well equipped Forest Research Station at Buitenzorg, Java, which directs various experiments and researches, and besides affords assistance and advice in many cases where such researches are being made.

Herewith we conclude this short sketch of the main problems involved in Forestry in the Outer Provinces. Naturally, the survey here given is superficial. But inadequate as it is, this account will have proved to the reader that, although there is still much to be done in the matter of organization, we are on the right road and that the task before the Forestry Service is in itself as promising as it is large.

# ASTRONOMY IN THE NETHERLANDS INDIES

*by*

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*1.* American interest in Astronomy as practiced in the East Indies springs from two main sources:

*a.* the founding of and the work at the Bosscha Observatory;

*b.* the several eclipse expeditions by American and other astronomers to the East Indian islands.

The first activity parallels a development well represented in the U.S.A. but uncommon in Europe, of the creation of a large scientific institution by private citizens rather than by State-supported Universities. The second activity has produced many personal contacts between this country and the Indies; the official support given to the visiting scientists and the reception accorded them by the people of the Indies has not been forgotten (1).

There is a third reason, less generally known, why the Indies play a rôle in Astronomy: the names of the far-Southern constellations were invented and assigned by DE HOUTMAN and KEYSER on their first voyage from Holland to Java in 1598. They issued the first catalogue of these stars and their results were incorporated on the famous celestial globes of BLAEU (2–4) (Fig. 66).

*2.* Since the Bosscha Observatory is the heart of astronomical activity in the Indies we shall now describe briefly the history of its foundation (5–10).

While the Indies, as other countries, had in the past their share of amateur astronomers (11), no important scientific work was done there prior to the founding of the Bosscha Observatory about 20 years ago. The foundation was the result of the collaboration of Mr. K. A. R. BOSSCHA, prominent pioneer in many fields and generous donor, with Dr. J. VOUTE, a zealous

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

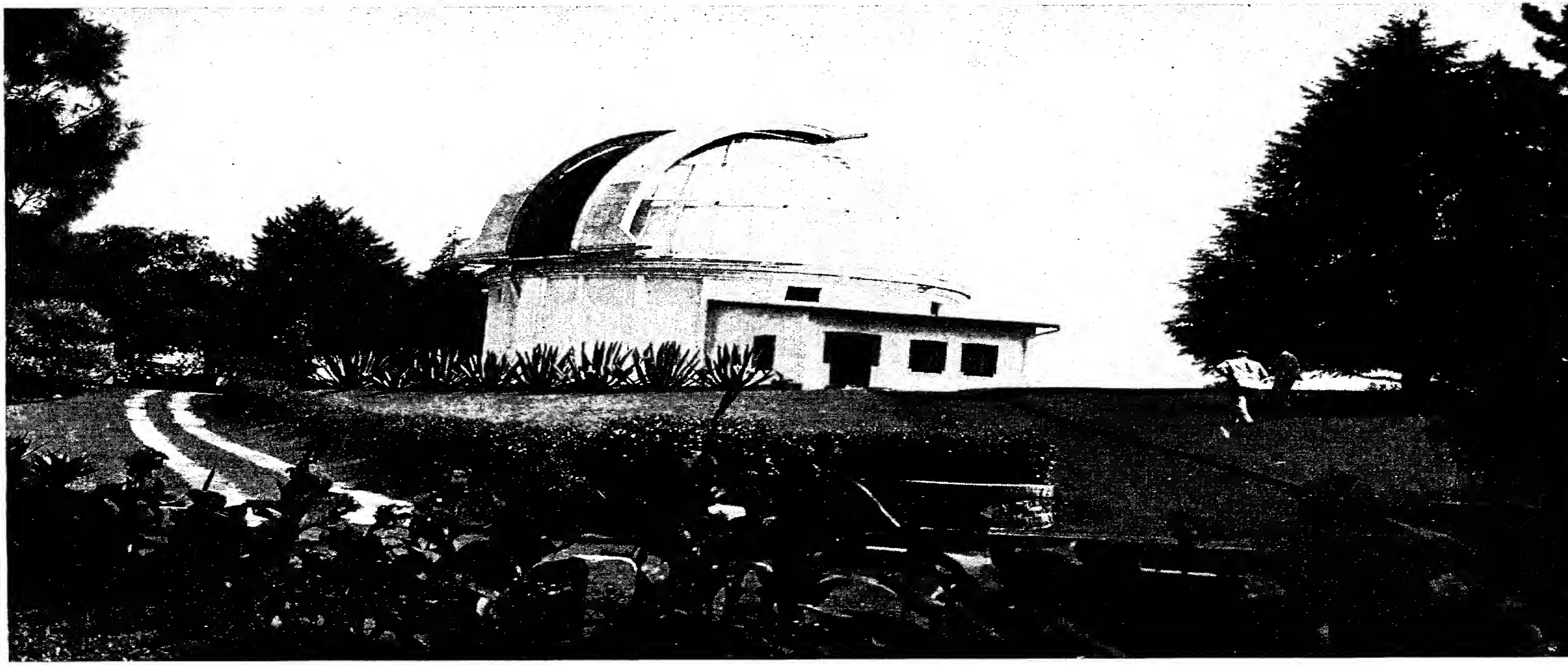


Figure 65. — The Bosscha Observatory at Lembang near Bandoeng. — *Courtesy Netherlands Information Bureau, New York City.*

astronomer and a graduate of the Institute of Technology at Delft, Holland.

Mr. BOSSCHA, son of the well-known Dutch physicist and textbook writer of the last century, was himself a graduate of Delft. He was a pioneer in developing tea plantations on rugged mountain slopes hitherto covered by primeval tropical forests. He developed telephone communications through the cultivated areas and started on his plantation a continuous and valuable series of seismic observations. This series, together with that obtained at the Government Station at Batavia, has determined accurately the epicenters of the earthquakes in the Indonesian Archipelago. BOSSCHA was a leader in civic and educational affairs. In later years he was President of the Board of Trustees of the Netherlands Indies Institute of Technology at Bandoeng, Java.

Dr. VOUTE started his astronomical career at the University of Leyden, Holland, where he specialized in double stars. Later (1913–1917) he worked at the Cape Observatory, Capetown, South Africa, specializing in stellar distances (parallaxes) and motions as well as in double stars. His later work at the Bosscha Observatory was exactly on these same lines, and the telescopes and auxiliary equipment were designed with these programs in mind. For this reason it may be of interest to indicate briefly the importance of double-star and parallax observations for modern astronomy.

The central problem in Astronomy is that of the evolution of the stellar world (which includes the Sun and the Earth): what is the present development of the stars; where do the stars come from; what is their future? The first question (which has to be answered before the others can be answered) is answerable when the energy generation in the stars is fully understood; great progress in this latter field has been made during the last decade. The study of the energy generation requires detailed information on nuclear physics on the one hand, and observed masses, diameters and brightnesses of stars on the other hand. The latter data are provided by double stars for which also the parallaxes (distances) have been measured. These double stars are of two kinds: visual double stars, measured with a micrometer on a large telescope in a good climate; and spectroscopic double stars, recorded with a spectrograph, preferably attached to a large reflector. For a complete study of stellar problems both groups of observations are needed, since as a result of certain selection effects imposed by the techniques of the two methods, the accessible visual double stars are mostly objects of small mass and the accessible spectroscopic double stars objects of large mass.

As we shall see below, the Bosscha Observatory is well equipped to deal with visual double stars; it has at present no equipment to deal with spectroscopic double stars.

During the last quarter of a century there have been only about a dozen visual double-star observers, and Dr. VOUTE has been prominent among them. The many thousands of measures made by him, as well as those made by his colleagues, are part of the solid empirical foundation upon which modern Astronomy is built.

In 1920 Mr. BOSSCHA took the first step toward the building of an Observatory by founding the East Indian Astronomical Association (Nederlandsch-Indische Sterrenkundige Vereeniging), which was to promote, and later administer, the Observatory. With Dr. VOUTE he travelled to Europe in 1921 to work out with the manufacturers the details of the installations. He acquired, by purchase or donation, several smaller telescopes which enabled Dr. VOUTE to start the observations in January of 1924, more than four years before the big twin 24-inch telescope and the 14-inch telescope were completed. Mr. BOSSCHA ordered the big telescope from Zeiss, the 14-inch from Bamberg, also in Germany.

The main dome (Fig. 65) was erected in 1925–26. The twin telescope, consisting of a 24" visual and a 24" photographic telescope mounted together inside one large tube, was inaugurated in June 1928, when Mr. BOSSCHA, in the presence of the Governor-General and other high officials, formally presented the completed Observatory to the Astronomical Association. Mr. BOSSCHA remained the principal supporter of the Observatory till his death in November 1928. After that date the financial support was received from three sources: *a.* a Government subsidy; *b.* a trust fund created by BOSSCHA; *c.* other substantial legacies and donations.

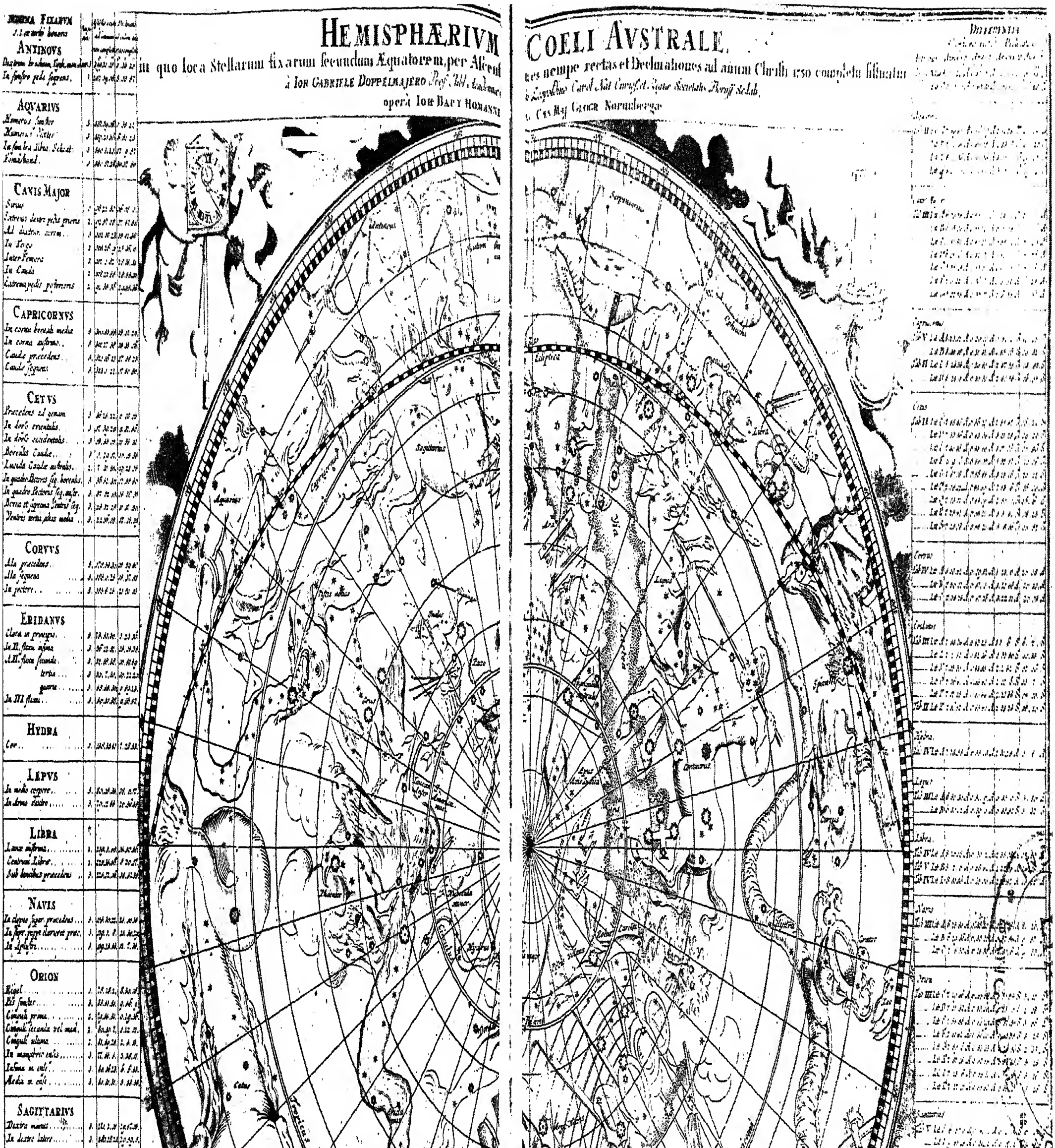
*3.* The Observatory is situated near the small town of Lembang and is within easy driving distance (10 miles by road) from the city of Bandoeng, second-largest center in West Java. Bandoeng is an administrative center and the site of the Institute of Technology. Occidentals enjoy its comfortable climate (el. 2300 ft.) and its magnificent surroundings. The Observatory is built on the slope of one of the mountains surrounding the city. The site is 4200 ft. above sea level and has a clear view except near the Northern horizon. The mean daily maximum temperature is 75° F., the mean daily minimum 60° F. Seasonal variations in these values, expressed in monthly averages, amount to only 3° F. As is common in the tropics, the mornings and latter parts of the nights are mostly clear, while the afternoons and evenings are frequently cloudy. Heavy dews are common in the early morning; the average relative humidity is 92% at 6 A.M., and 70% at noon.

The telescopic images are frequently very steady; this, too, appears to be typical for the tropics. It makes the site favorable for difficult visual observations, as the measurement of visual double stars, or the study of planetary markings. Spectroscopic work, not now a part of the program, would be possible in the normal visual and photographic region of the spectrum, but there might be some difficulties in the extreme ultraviolet and infrared due to reduced atmospheric transmission.

The latitude of the Observatory is 7° South so that nearly the whole sky may be observed. With half a dozen other Southern observatories, in South Africa, South America and Australia, it shares in the opportunities presented by the richness of the Southern Milky Way. In no other part of the heavens do so many interesting and unusual stars occur. These objects are invisible at American and European observatories.

The scientific work at the Bosscha Observatory was begun by Dr. VOUTE in 1924. He measured double stars with a 7½ inch refractor

FIGURE 66. — A map of the Southern Sky, showing DE HOUTMAN and KEYSER'S nomenclature of the far-southern constellations, reproduced from DOPPELMAYER'S *Atlas Novus Coelestis* (1742). —*Courtesy Dr. F. E. Brasch of the Library of Congress.*


HEMISPHÆRIVM COELI AVSTRALE,
in quo loca Stellarum fixarum secundum Æquatorem, per Ascensiones nempe rectas et Declinationes ad annum Christi 1730 completum sistuntur
à IOH GABRIELE DOPPELMAJERO
opera IOH BAPT HOMANNI
NOMINA FIXARVM
ANTINOVS
AQVARIVS
CANIS MAJOR
CAPRICORNVS
CETVS
CORVVS
ERIDANVS
HYDRA
LEPVS
LIBRA
NAVIS
ORION
SAGITTARIVS
SCORPIVS
SERPENTARIVS
SERPENS
VIRGO
Sagittarius
Aquarius
Cetus
Serpentarius
Libra
Lupus
Centaurus
Corvus
Eridanus
Sirius

donated by the Leyden Observatory. The first series of measures was published in the "Annalen" in 1926.

During the first half of 1926 a detailed study of the brightness of the Southern Milky Way was made by a visiting scientist, Prof. PANNEKOEK of Amsterdam. Later in 1926 Dr. P. TEN BRUGGENCATE joined the staff. He stayed two years and was succeeded by Dr. WALLENQUIST of Uppsala, Sweden and Dr. KREIKEN of Amsterdam. KREIKEN left in 1930, WALLENQUIST in 1935. Later a Russian astronomer, Dr. SIMONOW, joined the staff temporarily, and still more recently Drs. W. C. MARTIN and A. DE SITTER from Leyden went to Lembang. TEN BRUGGENCATE made important contributions on variable stars, WALLENQUIST and MARTIN on clusters and star clouds, while TEN BRUGGENCATE, WALLENQUIST and SIMONOW participated in VOUTE's double-star program. Drs. MARTIN and DE SITTER as well as Dr. VOUTE were in Java at the time of the Japanese invasion in 1942.

The total volume of the scientific work produced at the Bosscha Observatory is impressive. Some of the contributions were completed after the astronomers had returned to their native lands. A substantial part of the double star results are still unpublished.

It is to be hoped that after the liberation of Indonesia the Bosscha Observatory may resume its rightful place in the cultural life of that country. Its equipment measures up to the more modern medium-sized American observatories, and compares well with its Southern sister institutions. If in the future a 60-inch reflector with spectrographic equipment could be added (at the cost of perhaps $150,000) a well balanced and modern research institution would be created that could maintain a front-line position in the study of the Universe.

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# THE DEVELOPMENT OF THE ZOOLOGICAL MUSEUM AT BUITENZORG


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Forty years ago, early in August, 1901, the Zoological Museum at Buitenzorg was established. Although, because of present conditions this event will be commemorated in only a small circle of direct collaborators, it seems well to devote a few words in the "Natuurwetenschappelijk Tijdschrift" to the vicissitudes of this, the oldest zoological institution in the Netherlands Indies.

The history of establishing a center in this country for zoological research goes back much farther than 1901. In 1894, Dr. J. C. KONINGSBERGER was appointed agricultural zoologist at 's Lands Plantentuin. He was appointed on a temporary basis and paid out of special funds. Before his time, zoological research had been limited to the visits of a number of expeditions or to the temporary sojourn in the Archipelago of zoologists, who collected material which they later worked over in Europe. Now an effort was being made to give the worker an opportunity to complete his investigations in the country where he had gathered his specimens.

The quarters assigned to KONINGSBERGER—they had the very broad title "Landbouw-Zoologisch Laboratorium"—were exceedingly modest. The coach house of a home that had been occupied by a medical officer was changed from a shed to a workroom and so became the zoological laboratory of 's Lands Plantentuin. The chests and flower pots were cleaned out; the floor was cemented; the entire place was enlarged and fitted with plumbing. So, the annual report for 1894 stated, "a very well lighted room had been obtained . . . that sufficiently satisfied the demands for a zoological laboratory."

In the beginning, KONINGSBERGER devoted himself entirely to the study of animal parasites

* Translated by Dr. LILY M. PERRY, the Arnold Arboretum, Harvard University, from the authors' account "Het Zoologisch Museum te Buitenzorg Veertig Jaar" in *Natuurwet. Tijdschr. Ned. Indië* 101:249–257 (1941).

in the various cultivated crops: first of all, coffee; later pepper, rice, tobacco, cacao, and so forth. But he very quickly saw how little was known of the fauna of Java. Hence, he devoted himself directly to satisfying the need both for a standard collection as help in identifying the various parasites and for a library. For the library, the "Koninklijke Natuurkundige Vereeniging" was willing to loan a number of books for an indefinite time. The collection, however, had to be built from the ground up; yet, after only a year, it became so extensive that a catalogue was necessary.

In the meantime Dr. KONINGSBERGER was transferred to government service. A government inquiry into the desirability and possibility of taking measures to protect useful species caused him to turn to the study of animals other than parasites. The first animals to be considered were the birds, and the occurrence of rodent plagues turned his attention to mammals. As a result extensive collections of both these groups were made.

In 1899 KONINGSBERGER went to Europe on furlough. He took the entomological collections along in order to identify them in the larger European museums. At the same time, he was to make contacts with European research workers and to discuss various aspects concerning the establishment of a zoological and phytopathological museum in the Netherlands Indies. KONINGSBERGER had first conceived this idea during a visit to Ceylon a year before. There he saw the zoological collections of the museum at Colombo. He wrote in his report: "The writer earlier has labored under the delusion that in a tropical climate it is almost impossible to keep a zoological museum in merely moderately good condition. A visit to the collections at Colombo has shown the falseness of this idea." And further: "It is rather humiliating for us, residents of the Netherlands Indies, that we can point to nothing comparable in some measure therewith." "Such a museum should be of very great significance to us for two reasons: first, because the number of zoologists who come to Java constantly increases; second, because a museum especially can be a useful guide, if it is designed to answer all kinds of questions of practical value, particularly those related to agriculture."

In a later report KONINGSBERGER formulated what may be considered a most fitting answer to those who even nowadays do not consider systematic zoological research desirable: "A phytopathological collection relating to a country such as Java, whose fauna in all its branches is still so incompletely known, is not well conceived unless a more systematically arranged zoological collection be connected with it. Indeed, the mammal, the bird, or the insect that to-day is still practically unknown can tomorrow appear as an enemy of the planter, and by so doing move from the zoological section to the pathological."

At the insistence of KONINGSBERGER, Messrs. H. D. KRAMER, director of the "Nederlandsch-Indische Landbouw Mij.," and TH. J. VAN HAREN NOMAN, director of the Nederlandsch-Indische Handelsbank, took the initiative in raising an amount of fl.15,000 to defray the expense of building a museum. Of that, only fl.12,000 was forthcoming, but the government promised another fl.6,000 for building and equipment, and in September 1900 the structure was begun.

In the meantime, the state of affairs in the old laboratory had become unendurable. The entire room was only $8\frac{1}{2} \times 5\frac{1}{2}$ m., and therein both the collections and the research workers had to find a place.

In August 1901, the building was so well advanced that the workrooms were ready for occupation. The new edifice consisted of a large hall to be used for the public museum and four smaller rooms intended partly for working space and partly for the systematic entomological collection. One room was reserved as a laboratory for zoologists who came as guest workers. The plan of the building was drawn by Ir. MELCHIOR at Batavia.

Fourteen days after the opening, the Russian zoologist, Dr. P. PEDASCHENKO, moved in, the first of a long series of research workers in the guest laboratory.

The collections included a number of stuffed birds and mammals very quickly supplemented by a collection brought together by Dr. A. W. NIEUWENHUIS in Borneo, a collection of lower vertebrates in liquid, the conchological collection lent to the museum by the "Koninklijke Natuurkundige Vereeniging," a phytopathological and a systematic-entomological collection. Mr. M. E. G. BARTELS and Major P. A. OUWENS helped most generously in replenishing, arranging, and working up the materials.

In 1902 the project was so well advanced that the part intended for the public could be opened. That same year the collection of Dr. A. G. VORDERMAN was purchased. The transaction deserves mention because this is the collection which formed the basis of the material used for the numerous publications of that eminent ornithologist. It contains all the types of species which VORDERMAN described. With it, at the same time, was laid the foundation for a fine systematic ornithological collection under the management of the museum. Alas, many of the birds from this collection were stuffed; in addition, over a period of years the care was not without fault. So a small part has been lost. In the same year the first collecting expedition outside Java in behalf of the museum was undertaken by a native hunter who went to Telok Betong. In the scope of this short account it is not possible to give in detail all the donations and accessions. But it might be mentioned that the first of the long line of voluntary collectors and co-workers who have contributed so much to the completion of the present collections of the museum was SECH SAID BIN ABDULLA BAÄDILLA, Lieutenant of the Arabians at Banda Neira. He presented a collection of corals and birds of paradise.

In 1905 a small laboratory for marine research was established at Batavia, as a subdivision of the museum. Later, as "Laboratorium voor het Onderzoek der Zee," it grew to be an independent section of 's Lands Plantentuin.

The year 1905 was important for the museum in another respect. Mr. P. A. OUWENS, a retired army major, announced that he was prepared to take over the supervision of the zoological collections. "Majoor OUWENS," as he was known everywhere, had from his earliest youth been a lover of the animal world. During his career as an officer, by persevering study and patient observation, he had reached such scientific eminence that scholars of reputation gladly made use of his knowledge. His offer then was extremely fortunate. KONINGSBERGER, who for some years

had been so engrossed in other work that he had had no time to help with the collections, remained the executive chief of the department. For sixteen years OUWENS devoted his best efforts to the museum. The collections grew enormously, especially those in that part of the museum open to the public. With how much enthusiasm OUWENS worked is shown by the fact that at the end of a year the museum building was obviously too small. Moreover, the public was much more interested than had been expected. The annual report of 1906 contains the lament that pecuniary circumstances did not permit the appointment of a few guards, because the "naive amazement of hundreds of brown brothers and sisters often expresses itself in a way which bodes ill for cabinets and window-panes."

FIGURE 67. — A DIORAMA OF PROBOSCIS-MONKEYS (*Nasalis l. larvatus*) IN THE ZOOLOGICAL MUSEUM, BUITENZORG.

The first change in the museum took place in 1907. Two new workrooms and a working space for the Indonesian personnel were prepared. Some of the earlier laboratories were transformed into museum rooms.

The museum contributed in no small measure to the expansion of our knowledge of the fauna of the Netherlands Indies. For example OUWENS named and described a new species of dwarf buffalo (*Anoa quarlesi*) and of the giant monitor lizard (*Varanus komodoensis*).

In 1910 the museum building again became too crowded, and a new room was added. In 1913 the staff was enlarged by the appointment of Mr. B. STRASTERS as temporary assistant custodian.

In 1914 — our account becomes tedious — for the third time there was need for expansion, and again a new museum room was built in addition to some sheds.

Meanwhile war broke out and it was hard to obtain material for the institution. Thus it happened that the beautiful skeleton of a whale (*Balaenoptera musculus*), which came into the possession of the museum in 1916, had to be housed provisionally in a shed. The salvaging of this leviathan was in itself a matter of great difficulty. The bones, weighing 6390 kg., had to be transported by manpower through hazardous country that averaged 1700 m. above sea level and had neither roads or bridges from the south coast of the Preanger to Garoet, and from there by train in four cars to Buitenzorg. The moving required forty-four days. The honor of achieving this feat belongs to Mr. W. REUTER, who had succeeded Mr. B. STRASTERS as assistant curator. Two years passed before the animal was temporarily mounted. Alas! This most important piece of the show collection stands to this day in the same provisional structure.[1]

It is worthy of mention that in 1915 a zoological periodical, *Contributions à la Faune des Indes Néerlandaises*, was published for the first time. In 1919 this was replaced by *Treubia* which, as the organ of both zoological institutions of 's Lands Plantentuin, has won an outstanding name throughout the world.

Since 1910 the position of head of the Zoological Museum and Laboratory had been combined with that of the director of 's Lands Plantentuin. From its very nature such an accumulation of functions cannot benefit the museum. Although the curator acquitted himself more than meritoriously in a task the execution of which rested entirely on his shoulders, yet more and more the need for an academically trained zoologist was felt. In July 1919, Dr. K. W. DAMMERMAN was appointed head of the museum. Thus, this position was again separated from that of director of 's Lands Plantentuin.

Filled as he was with new plans and ideas, even in his first yearly report (for 1919) DAMMERMAN pointedly wrote, "The Museum gradually becomes crowded; as expansion is no longer possible, a new building is very much needed. Also, to show at last the Zoological Laboratory to full advan-

[1] An ample description of the morphology and of the skeleton of this whale, illustrated with photographs and drawings, written by W. REUTER, appeared in Treubia, 1, 1919, pp. 101–138.

tage for at present it actually exists only on paper . . .," a statement which expresses a need that will not grow less for many years.

With DAMMERMAN'S appointment the course previously followed was somewhat changed. More attention was spent on the expansion of the study collections and on the systematic biological research on the fauna of the Netherlands Indies, without, however, neglecting the modernization of the public museum and consequently the enlightenment of the general public. In imitation of the line of action followed in the British dominions and colonies, the faunistic research of the archipelago was energetically undertaken.

Shortly before the resignation of OUWENS in 1920, two zoologists were appointed as assistants: namely, Mr. H. C. SIEBERS, to whom the care of the vertebrate collections was entrusted, and Dr. H. H. KARNY, who, as entomologist, was given charge of the insect collections. Mr. A. BLANCHEMANCHE was designated assistant curator. And finally in 1922 there followed the appointment of Mr. P. F. FRANCK as taxidermist. These appointments, very ample for the time, and the employment of an extra worker were definitely progressive steps.

Of the many expeditions and collecting trips in the period from 1920 to 1928, whereof the museum profited, we mention the explorations of the fauna of the Krakatau group (DAMMERMAN, 1919, 1921, 1924, 1928), the Netherlands New Guinea Expedition (W. C. VAN HEURN, 1920), the Boeroe Expedition (L. J. TOXOPEUS, 1921–1922), Lampongs (KARNY & SIEBERS, 1921), Doerian (DAMMERMAN, FRANCK & SIEBERS, 1923), Idjen (DAMMERMAN, 1924), Mentawei (KARNY, 1924), West Borneo (BLANCHEMANCHE, 1924–1925), Soemba (DAMMERMAN & FRANCK, 1925), Middle East Borneo (SIEBERS, 1925), Northwest Sumatra (KARNY, 1925), Sangihe and Talaud (1926), and Karimondjawa (DAMMERMAN & FRANCK, 1926).

During this — though rather one-sided — flowering period of the Zoological Museum there was a very close co-operation with foreign zoological institutions.

The yearly report tells, on the other hand, of less agreeable things as wall cracks appeared in the main building because of the settling of the ground; complaints about the lack of space became also more and more urgent.

On the other hand, the show collections were rejuvenated; the cases, stuffed with "dead animals mounted on little supports, with bulging glazed eyes," made way for small dioramas; and the number of visitors increased considerably.

FIGURE 68. — A DIORAMA OF OTTERS (*Lutra cinerea* Ill.) IN THE ZOOLOGICAL MUSEUM, BUITENZORG.

In 1924 a number of colleagues got together. The museum again was filled! Because the desired expansion, if made in a horizontal direction, could not possibly be satisfactory, it was resolved to add an upper story to the building, one covered with corrugated sheet iron. In this way a very hot yet dry room for the special housing of the systematic collections would be obtained. This space, the later famous "kamar panas," was ready in 1925, and therewith 96 square meters were gained.

Meanwhile, the taxidermist and his staff occupied the old printing office, the only place large enough for the dressing of skins and the mounting of larger animals.

Perhaps it is still worth mentioning that in August 1924 the first reputable evidence of the existence of the "orang pendek" was found in Sumatra. From a journey into the highlands of Palembang, Dr. A. STEINMAN brought back a photograph of a footprint that was attributed to this ape-man (or man-ape) so much discussed at that time. The original footprint came into the possession of the museum, whereupon DAMMER-

MAN, with sufficient certainty, identified it as that of a bear.[2] Later, the interesting mystery of the "orang pendek" once more was of immediate interest; [3] after that it was almost forgotten.

In May 1926, Dr. DAMMERMAN and the *Neth. Indies Committee for Scientific Researches* began discussing the possible transfer of the museum to Batavia, considering particularly ways of raising the money necessary for a new building. In August, DAMMERMAN, who had drawn up a comprehensive report on the subject, was disappointed by the municipality of Batavia, which had earlier promised all the stone and which had placed a building lot at his disposal. This plan, however, was not carried out. Seen in a broader perspective, this failure is not necessarily to be deplored, because it was after all just as well that the Zoological Museum became a subdivision of 's Lands Plantentuin, like many other scientific institutions at Buitenzorg. At the time the motives for a transfer were based exclusively on the necessity for more space and a drier environment.

In 1926 Dr. A. VORSTMAN was added to the staff as temporary assistant. She was occupied principally with the study of fresh water sponges and Bryozoa of the ponds and lakes of Java. In January 1928, Miss VORSTMAN left the museum.

The next period in the history of the museum we shall pass with only a fleeting glance. Before the outbreak of the great economic crisis of 1929, the entomologist KARNY was transferred to the Public Health Service, and very shortly thereafter left the Indies because of ill health. Although the maintenance of the collections definitely had not been his strongest point, through his enormous working power and numerous publications KARNY had contributed in no small measure to make the museum well known to the entire entomological world. In the same year, M. A. LIEFTINCK was appointed entomologist to take KARNY's place.

The ornithologist SIEBERS also left our institution. Although he was replaced for a short period by Dr. J. K. DE JONG, who in that time arranged the very valuable reptilian and amphibian collections, the subsection Vertebrata was left to its fate for a long time.

Fortunately after that, two years' leave was granted to Miss T. VAN BENTHEM JUTTING, zoologist at the Museum of Amsterdam, to study the Mollusca of the Netherlands Indies at the sister institution at Buitenzorg, and at the same time to give considerable attention to the invertebrate collections.

But the position of zoologist could no longer be protected from the already drastic retrenchment measures. Then Dr. W. M. DOCTERS VAN LEEUWEN was pensioned and left for Holland. DAMMERMAN was designated his successor. This was, moreover, an unwelcome opportunity to combine the work of director of 's Lands Plantentuin with that of the head of the Zoological museum.

So it happened that DAMMERMAN who, a year before, had undertaken the guidance of the Botanic Garden, in 1932 was definitely charged with this task. In the middle of 1935, when he departed on leave of absence for Europe, the museum became a "one man's laboratory" in which there fell to the entomologist the doubtful privilege of permitting himself the luxury of three workrooms!

It is difficult to deny that the "flowering period" had been followed by a time when the museum stood very much in the background.

The same may be said about the expeditions. Only a few of the most indispensable preparators were kept on; the funds were curtailed to the utmost and, what was most deplorable, the publication funds were so decreased that many articles by foreign workers intended for *Treubia* had to be rejected. It is surely noteworthy that, just in these depression years, foreign interest in the fauna of the Netherlands Indies began to increase greatly. A number of workers visited the museum or were active there for a shorter or longer time (HEINRICH, STEIN, VON PLESSEN, COLLIER, McCLUNG, BRISTOWE, CHEESMAN, etc.). Then too, in the face of the influx of strangers, it was far from simple to keep up appearances, as if everything were going very smoothly, and there are no reasons for concealing the repeated attempts from an unfriendly quarter to misuse the extremely weak position of our institution. Alas! We could not prevent important zoological collections from vanishing abroad.

We would rather not mention any particulars about the struggle to obtain adequate space for "dead material." That struggle, in those very difficult years, was successful only in continuing the museum with its valuable collections, and providing some space for new material. The remaining possibility was to ask for a new annex.

Meanwhile, the prolonged period of crisis had yielded a few benefits. The contact with foreign specialists had been intensified. A modern method of keeping the valuable entomological collections in excellent condition indefinitely had been installed. The working over and organizing of the enormous arrears of material from the expeditions had been started. And last but not least, since expansion through the purchase of zoological specimens had now been entirely excluded, the museum obtained a number of loyal collaborators in the outer districts.

Early in 1934, there was considerable interest when the museum succeeded in obtaining a beautiful specimen of an old male Javanese rhinoceros (*Rhinoceros sundaicus*). The fate of this solitary male, a stray from his original territory, had been sealed before it was decided to save him for science. Sooner or later the animal would have fallen into the hands of poachers. After a four-day hunt, the leviathan (which appeared to weigh no less than 2280 kg.!) came within range. A path $2\frac{1}{2}$ meters broad had to be opened before the hide and complete skeleton could be carried out of the thick forest; and it goes without saying that there were still greater difficulties to be encountered before the animal was safely delivered at Buitenzorg. The original weight of the raw hide had to be reduced, by dermatoplastic work, from 600 to 45 kg. As is known, the "badak" is threatened with extermination even within the Oedjoengkoelon reservation in West Java, although the most drastic measures have been taken to assure the survival of the few remaining specimens. Very little is known of the occurrence of this species in Sumatra. For that reason, the extant mounted specimen in the Buitenzorg Museum is a very valuable possession, because it will very probably remain the only full-grown male of *R. sundaicus* to be seen

[2] See K. W. DAMMERMAN, De orang pandak van Sumatra (De Trop. Natuur 13, 1924, pp. 177–182).

[3] See K. W. DAMMERMAN, De nieuw-ontdekte orang pendek (De Trop. Natuur 21, 1932, pp. 123–131, fig. 1–3).

in an easily accessible place. Details concerning this animal have since been made known [4] in many domestic and foreign publications.

In 1935 the museum lost Mr. HOOGERWERF who, for a few years, had been second taxidermist at our institution. Beautiful bird groups were arranged under his guidance. Moreover, HOOGERWERF had helped surmount a number of difficulties in this period of the museum's existence. Two years later, he went to North Sumatra as zoologist with the Leuser Expedition. There, assisted by two native preparators, he gathered specimens of birds for the museum. This collection was the most interesting and the richest in species ever brought together in Sumatra.

With this we have almost finished our historical review. The resignation of Dr. DAMMERMAN as director of 's Lands Plantentuin in February 1939 made it possible to engage again a second zoologist; at the same time it concluded a seven-year period in which 's Lands Plantentuin and the Museum had been under the leadership of a single person. In 1937 A. C. V. VAN BEMMEL was appointed zoologist; and at the beginning of 1940 M. A. LIEFTINCK, an entomologist with the museum, became the director.

The outbreak of the World War prevented the appointment of an entomologist, for whom there is a constantly growing need; nevertheless, it is expected that this position may be filled in the near future. In the middle of 1940, Dr. H. J. VOS was appointed hydrobiologist to the zoological laboratory, which was once more active.

The activities of the museum proper "make orderly progress," as the amusing official expression says, thanks to the museum's two-year detailing of Dr. L. J. TOXOPEUS to work over the unique *Lepidoptera* collection which he had made during the latest Archbold New Guinea Expedition; further, through the addition of J. OLTHOF as curator of the division of entomology; and finally through the replacement of the former taxidermist by A. DE VOS, to whose care the modernizing of the public museum has been committed.

This jubilee offers a welcome opportunity to devote a few words to the future of the Zoological Museum. If this institution is fittingly to accomplish its task, the following needs, although in part rather costly, must shortly be met.

*1.* The establishment of a modern museum for systematic zoology, in which building the exceedingly valuable study-collections can be kept in a constantly dry atmosphere, accessible for examination, arranged in systematic order, and available for consultation without special effort.

*2.* The establishment of a zoological laboratory offering opportunity for the study of such important branches of zoology as hydrobiology, evolutionary mechanics, mode of living, and ecology of animals in which especially the specific tropical side of the problems is illustrated.

*3.* The substitution, for the existing show rooms with their old-fashioned and absolutely unsuitable illumination, of a modern public museum building with built-in mural dioramas indirectly lighted from above; incidentally, it might be mentioned here that the already extant biological groups (vertebrata) have been adapted without much difficulty to this new setting. Furthermore there is the exhibit of community life: groups of specific tropical animals in their natural surroundings — the fauna of the beach, the rice-field, the coral reef, the mangrove, etc.

These are the ways in which the only established zoological institution in the Netherlands Indies can show itself worthy of a place. It has a beautiful and versatile task: on the one hand, it is to form an "arsenal of zoology" in behalf of practical people and scientists; and, on the other, it is to give instruction about the animal world of the Indies, in its widest sense, to the European and Indonesian population of the Netherlands Indies.

[4] See *e.g.* F. J. APPELMAN & P. F. FRANCK, Rhinoceros sundaicus in West Java (De Trop. Natuur 23, 1934, pp. 73–79, fig. 1–2).

# NOTES JAVANAISES

*par*

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De tous les jardins botaniques du globe, celui-ci est sans contredit le plus beau. Couché au pied des volcans dont les hautes cimes condensent les vapeurs atmosphériques et les font journellement retomber en pluies fécondantes, Buitenzorg occupe une situation privilégiée dont le gouvernement de l'Insulinde a tiré le plus heureux parti.

Lorsqu'en 1815, les colonies de l'archipel Indien, gouvernées pendant quelques années par les Anglais, furent de nouveau cédées aux Hollandais, le premier soin de ceux-ci fut de créer à Buitenzorg un grand jardin botanique destiné aux études scientifiques et aux essais d'acclimatation des plantes utiles. Depuis quatre-vingts années, l'institution de Buitenzorg ('s Lands Plantentuin) n'a cessé de se développer, et aujourd'hui, grâce surtout aux efforts persévérants de M. le Dr M. TREUB, qui en est directeur depuis 1880, il est devenu un établissement sans pareil. Certes, il y a bien d'autres Jardins de premier ordre, et il faut tout d'abord citer celui de Kew. Le budget des deux établissements est à peu près le même: un demi-million de francs. Mais tandis que les Kew Gardens doivent consacrer une forte portion de cette somme à entretenir un grand jardin d'agrément et des serres luxueuses, 's Lands Plantentuin, au contraire, emploie la totalité de son budget à une destination scientifique. Disons tout de suite que cette énorme somme annuelle n'est pas donnée en entier par le gouvernement de l'Insulinde. Une part importante est versée par les

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planteurs de Java et de Sumatra; comprenant que pour soutenir la lutte économique contre les producteurs des autres colonies, ils doivent s'inspirer du progrès scientifique, ils se sont entendus pour faire bâtir dans le jardin de Buitenzorg des laboratoires spécialement outillés en vue de recherches d'intérêt pratique: maladies du riz, de la canne à sucre, du tabac, du caféier, etc. Quoiqu'ils ne soient installés que depuis peu de temps, ces laboratoires ont déjà donné des résultats remarquables, notamment pour l'étude du tabac. La découverte d'un procédé pour combattre une maladie qui ravage les cultures de tabac à Deli (Sumatra) a valu au botaniste chargé de ces études, une gratification de soixante mille francs. Inutile d'ajouter que si les planteurs accordent de semblables primes, c'est que la découverte de ce moyen représente pour eux un profit de plusieurs millions.

's Lands Plantentuin se compose du jardin botanique proprement dit, situé à Buitenzorg, du jardin d'essai de Tjikeumeuh et du jardin de Tjibodas sur le volcan Gedeh.

Le jardin de Buitenzorg, qui a une superficie de 58 hectares (celui de Bruxelles est grand de 5 hectares), est consacré exclusivement à la science botanique. Ici se trouvent réunies les admirables collections de plantes provenant de toutes les contrées équatoriales de la terre. Le botaniste européen, fraîchement arrivé dans cet éden, reste pendant les premiers jours stupéfié, confondu, en présence d'une pareille accumulation de richesses. C'est peu à peu seulement que les idées redeviennent claires et que l'esprit réussit à se débrouiller au milieu de cette féerie. Mais alors, quel enthousiasme! Chaque promenade dans le jardin procure de nouvelles extases, et le botaniste revient au laboratoire avec une pleine brassée de ces végétaux extraordinaires qu'on ne connaît en Europe que par les livres, ou dont on ne voit dans les serres que des échantillons si malingres, si délicats, qu'on ose à peine respirer devant eux. Ici, nous les voyons vivre, nous les étudions à l'aise, nous les soumettons à l'expérimentation, car le laboratoire est tout proche, large et spacieux, non une petite chambre étriquée avec un outillage rudimentaire, comme il en existe dans d'autres Jardins équatoriaux, mais une salle de travail installée tout comme un institut botanique d'Europe, dans laquelle aucun perfectionnement ne fait défaut, où l'on a tout à sa disposition: l'eau, le gaz, la force motrice, les instruments, les livres et, mieux que cela, l'aide et les conseils du directeur et des chefs de service. M. TREUB n'a rien négligé pour mettre l'établissement au premier rang. La ville de Buitenzorg n'ayant pas le gaz, le directeur a fait construire deux usines, l'une pour les laboratoires de Buitenzorg, l'autre pour ceux de Tjikeumeuh. Il a installé un laboratoire de chimie pharmacologique pour l'étude des nombreuses drogues que fournit Java, "l'Ile des Poisons." Il a aménagé pour les visiteurs étrangers un grand atelier de photographie. Il a réuni une bibliothèque extrêmement riche, des herbiers, des collections de tous genres...

Mais la place manquait à Buitenzorg pour faire en grand les essais de culture coloniale. En 1875 fut créé à Tjikeumeuh, à quatre kilomètres de l'établissement principal de Buitenzorg, un jardin d'essai de 72 hectares, dans lequel on s'occupe uniquement des espèces utiles. A Buitenzorg, la science botanique; à Tjikeumeuh, les applications. Il ne faudrait pas croire pourtant qu'on se contente d'introduire les plantes, de les acclimater, de définir empiriquement quelles sont les meilleures conditions de culture. Ici également nous trouvons des laboratoires techniques où l'on analyse les produits pour indiquer aux planteurs quelles sont les variétés le plus recommandables; des chimistes essayent de nouvelles méthodes d'extraction; ils comparent les produits de toutes les espèces qui fournissent du caout-chouc, de la gutta-percha, de l'indigo, etc.; ils recherchent des procédés pour perfectionner la préparation du thé, du café, de la vanille... On conçoit que les cultures industrielles tiennent une large place, néanmoins elles n'ont pas fait oublier que le riz est le fond de la nourriture des vingt-cinq millions d'habitants qui se pressent à Java,[1] et l'on a soin de faire voir aux Malais de rizières dans lesquelles une culture mieux comprise donne une récolte de beaucoup supérieure à celle qu'on obtient par les anciens procédés.

Enfin, s' Lands Plantentuin possède encore à Tjibodas, sur le versant N.-E. du volcan Gedeh, à une altitude d'environ 1400 mètres, un jardin de 31 hectares dans lequel on cultive les végétaux qui ne supportent pas le climat de Buitenzorg et de Tjikeumeuh (à l'altitude de 325 m.). Ce jardin a été créé lors de l'introduction des arbres à quinquina. Déjà le grand chimiste LIEBIG avait dit que la façon brutale dont on exploitait le quinquina en Amérique amènerait promptement la destruction de ces espèces. Si la prédiction s'etait réalisée, le mal eût été irréparable, car la quinine ne peut être remplacée par aucun autre médicament. Heureusement qu'en 1855, TEYSMANN, alors chef du Jardin de Buitenzorg, planta à Tjibodas les quelques échantillons de *Cinchona* qu'il avait pu se procurer à grands frais. Les plantes prospérèrent, de nouvelles variétés plus riches furent importées, et maintenant les volcans de Java sont garnis d'une ceinture de plantations du précieux fébrifuge.[2] Du jardin de Tjibodas dépendent environ 300 hectares de forêt vierge. M. TREUB a établi ici un laboratoire, unique en son genre, dans lequel le botaniste, après une longue excursion à travers la forêt encombrée de lianes et d'épiphytes, peut tout à son aise examiner au microscope les merveilles qu'il a récoltées.

Est-il nécessaire d'ajouter maintenant qu'un institut qui dispose de ressources si variées — jardin botanique, jardins d'essai, forêt vierge, laboratoires de botanique, de pathologie végétale, de chimie pharmacologique, de chimie agricole, atelier de photographie, bibliothèque, herbiers, etc. — a rendu des services incomparables à la science et à la pratique? Les *Annales du Jardin botanique de Buitenzorg* (à Leide, chez E.-J. Brill) font paraître sans cesse de remarquables mémoires scientifiques et constituent à l'heure actuelle l'une des principales publications botaniques. Les *Mededeelingen uit 's Lands Plantentuin* (à Batavia, chez G. Kolff en C°) ainsi que les *Verslagen van 's Lands Plantentuin* (ibidem), s'occupent plus spécialement

[1] Il y a 190 habitants par kilomètre carré; la densité de la population est donc plus grande qu'en Angleterre ou en France, à peine inférieure à celle de la Belgique.

[2] Grâce aux cultures de Java et à celles de Ceylan, faites avec des plants de Java, le prix de la quinine est tombé au dixième de celui auquel elle se vendait à l'epoque où toutes leurs écorces venaient de l'Amérique.

des applications pratiques et de la flore forestière.

Au point de vue des cultures coloniales, on ne peut évidemment pas exiger qu'un jardin introduise régulièrement chaque année l'une ou l'autre espèce importante. Les essais doivent se poursuivre avec lenteur et persistance, et souvent les résultats ne deviennent appréciables qu'après de longues années: alors seulement, le succès éclate aux yeux de tous. Ainsi, que serait devenue l'exploitation économique de Java, si le jardin de Buitenzorg n'avait pas indiqué le moyen de remplacer par le *Coffea liberica* les caféteries dévastées par un champignon parasite. Chacun, à Java, sentait nettement que la ruine ne pouvait être évitée que par l'introduction du *Coffea liberica*, et les particuliers s'empressèrent de faire venir des graines. Peine inutile; ces graines perdaient pendant le voyage leur faculté germinative. L'établissement scientifique de Buitenzorg était seul en état d'opérer l'introduction de jeunes plantes, et après quelques essais infructueux, on réussit enfin à faire vivre de jeunes exemplaires qui donnèrent des fleurs et des fruits. Les caféteries de l'île sont de nouveau en plein rapport, grâce aux graines de *Coffea liberica* obtenues à Tjikeumeuh, et qui, depuis 1878, sont distribuées aux planteurs.

Nous avons signalé plus haut l'immense service qui a été rendu à l'humanité par la culture et l'exploitation méthodiques des arbres à quinquina. Actuellement se pose une question du même genre. La gutta-percha est absolument indispensable à la confection des câbles sous-marins. Or, l'arbre qui fournit les meilleurs produits (*Isonandra Gutta* ou *Palaquium Gutta*) n'existait que dans la seule île de Singapore, et l'exploitation a été faite avec une telle âpreté que les derniers exemplaires sont tombés sous la hache. Par bonheur, le jardin de Buitenzorg possédait deux individus de cette espèce disparue, et maintenant les graines de ces deux survivants sont envoyées au loin et servent à créer de nouvelles plantations.

Ces quelques indications suffiront à faire ressortir le rôle prépondérant que joue 's Lands Plantentuin avec ses moyens d'action si nombreux et si variés. L'influence de cet établissement sur les destinées de l'Insulinde a été des plus profondes. N'oublions pas que non seulement Java produit de quoi nourrir son énorme population — plus dense que dans la plupart des pays européens, qui sont loin de se suffire, — mais qu'en outre, elle exporte chaque année, pour des centaines de millions de francs, du sucre, du café, du thé, du quinquina, du riz, des denrées de toutes sortes.

Enfin, chose encore plus importante pour nous autres, botanistes d'Europe, ces admirables jardins et ces laboratoires si bien installés sont mis gratuitement à notre disposition. Plus de quarante savants ont déjà profité de cette offre généreuse pendant ces dix dernières années. Plusieurs gouvernements d'Europe et d'Amérique envoient régulièrement des botanistes à Java, afin qu'ils puissent s'initier là-bas à la culture des plantes économiques et étudier sur place l'éxubérante végétation équatoriale. Buitenzorg n'est-il pas pour la botanique, comme le disait M. WIESNER, l'éminent professeur de Vienne, ce que la Grèce est pour l'archéologie et l'Italie pour l'art? Et pour prendre un autre exemple, la plupart des États européens n'envoient-ils pas chaque année des zoologistes à la station maritime de Naples?

Le climat de Buitenzorg est d'une douceur et d'une constance exceptionnelles: observer le temps qu'il fait un seul jour, c'est connaître le climat de toute l'année. L'abondance des pluies et la régularité de la température, oscillant autour de 25°, voilà ce qui caractérise ce climat enchanteur.

La quantité annuelle de pluie est d'environ $4^m,700$ (elle est à Bruxelles de $0^m,73$). Pendant le mois le plus humide (janvier) il tombe $0^m,473$ d'eau; pendant le mois le plus sec (août), $0^m,257$. On le voit, il n'y a pas ici de saison sèche. Bien plus, il n'y a pas de saison du tout. Les jours se suivent et se ressemblent: les matinées sont toutes également chaudes, et chaque après-dîner une violente averse rafraîchit l'atmosphère. Lorsque trois journées successives se passent sans pluie, tout le monde se plaint de l'intolérable chaleur (le thermomètre ne marque pourtant que 29 ou 30°!). Quant à des périodes de sécheresse de huit jours, elles sont tout à fait exceptionnelles et considérées avec raison comme une calamité publique. Il n'y a plus alors de temps à perdre; on recourt en toute hâte à des mesures énergiques, et l'on va en grande pompe baigner un chat blanc dans la rivière voisine.[3]

Tandis que la température moyenne de l'année égale 25°, celle du mois le plus chaud (septembre) est de 25,5°, et celle du mois le plus froid (février), 24,5°. L'oscillation totale de la température pendant toute une année n'atteint, du reste, que 9,2° (entre 30,1° et 20,9°). Comparez ces températures de la zone soi-disant torride avec celles qu'on observe à Bruxelles dans la zone appelée, par ironie, tempérée: la température moyenne de l'année équivaut à 10,3°; celle du mois le plus froid (janvier), à 2,3°; celle du mois le plus chaud (juillet), à 18,3°, soit une différence moyenne de 16°, contre celle de 1° à Buitenzorg. Les moyennes des températures extrêmes sont 30,9° et 10,7°, soit une oscillation annuelle de 41,6°, contre une oscillation de 9,2° à Buitenzorg.[4]

Faut-il s'étonner que dans un pareil paradis chacun ait l'air heureux, bien portant et content de son sort!

Ici, dans le pays du perpétuel été, le soleil décrit dans le ciel une tout autre course que chez nous. Il se lève à l'est, à six heures du matin (la différence entre le jour le plus long et le jour le plus court n'est que d'un petit nombre de minutes), monte tout droit dans le ciel, et arrive au zénith à midi. A ce moment, un objet vertical n'a plus d'ombre; depuis le matin, celle-ci s'était progressivement raccourcie, sans dévier ni à droite ni à gauche. Dès maintenant, elle s'allonge de nouveau à mesure que le soleil plonge directement vers l'ouest. L'aurore et le crépuscule sont sensiblement plus courts que chez nous, mais n'atteignent pourtant pas cette brièveté excessive dont parlent certains voyageurs.

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[3] Cette cérémonie bizarre qui a pour objet de conjurer les mauvais esprits, est un reste des antiques croyances du peuple javanais. La religion actuelle — s'il est permis d'employer ce terme à propos d'un peuple qui n'adore que la nature — est un amalgame baroque des croyances anciennes et des diverses religions qui lui ont été imposées dans le cours des siècles. Le bouddhisme a laissé le culte charmant des fleurs et des arbres, mais, en outre, les Javanais suivent à la lettre les prescriptions du Coran qui défendent l'usage des liqueurs alcocliques et de la viande de porc, ainsi que celles qui leur enjoignent la propreté corporelle.

[4] Les chiffres relatifs à Buitenzorg sont extraits de: G. HABERLANDT, *Eine botanische Tropenreise* (Leipzig, 1893). Ceux qui se rapportent à Bruxelles m'ont été obligeamment fournis par M. J. VINCENT, météorologiste à l'observatoire d'Uccle.

Au moment du réveil, vers cinq heures et demie du matin, le ciel est encore complètement obscur. Il fait très frais quoique le thermomètre marque 22 à 23°, et les gens qui sont dehors à cette heure matinale s'enveloppent frileusement dans une écharpe. En une dizaine de minute, on passe de la nuit noire au jour complet, et quand on sort de sa chambre pour aller déjeuner, le soleil luit déjà gaîment entre les arbres.

Une promenade de cinq minutes à travers la ville nous amène au jardin botanique. Les forçats de Buitenzorg se rendent, en même temps que nous, à la besogne. Ils sont réunis par groupes d'une vingtaine sous la conduite de cinq ou six gardiens, chacun tenant à la main la longue ficelle qui représente la chaîne. Ces condamnés ne paraissent pas malheureux: bien logés, bien nourris, vêtus d'un léger complet gris (une toute petite culotte, une veste et un large chapeau-parasol), ils causent allègrement entre eux. L'administration les emploie à balayer les routes, à entretenir le macadam, à arroser la voie carrossable. Quand ils arrivent à l'endroit où ils sont censés travailler, on roule soigneusement la ficelle, chaque homme prend son balai ou son arrosoir et va aussitôt se reposer jusqu'à midi, sous l'œil paternel des surveillants couchés à l'ombre. Rien de surprenant donc à ce que souvent, après dix ou quinze années de ces "travaux forcés," les prisonniers insistent pour n'être pas renvoyés. D'ailleurs ce ne sont généralement pas des criminels bien dangereux: les assassinats sont très rares à Java, et la plupart de ces condamnés ont commis de petits vols domestiques.

Un regard jeté autour de nous fait voir combien Buitenzorg diffère d'une ville d'Europe. Les maisons très spacieuses — mais composées d'un simple rez-de-chaussée avec un large toit qui dépasse de beaucoup le bâtiment — sont cachées au milieu de grands jardins et isolées les unes des autres par les arbres et les fleurs. Parmi elles nous remarquons le local de la "Societeit," où se réunit le beau monde de l'endroit pour écouter l'orchestre de la garnison qui, deux fois par semaine, y donne un concert.

Voilà l'école des filles. Qu'il serait bon d'être petite fille à Buitenzorg! La classe se fait — les avant-midi seulement — dans une vaste construction blanche qui s'élève au milieu de parterres de fleurs; portes et fenêtres restent tout le temps ouvertes. Les gamines, tout de blanc vêtues, se rendent en classe en sautillant et en bavardant. Ne sont-elles jamais distraites de leurs études par le parfum des jasmins ou les frémissements des feuilles de palmiers que balance la brise embaumée?

Une centaine de pas le long de la grand'route, et nous sommes au jardin botanique. De quelque côté que nous nous promenions, nous sommes certains de rencontrer des choses imprévues, nous nous arrêterons extasiés devant l'inépuisable variété de la nature équatoriale, et au bout d'une heure nous aurons récolté assez de raretés pour faire la richesse et la gloire d'un jardin botanique d'Europe. J'étais à Buitenzorg depuis plus d'un mois avant d'avoir pu arriver jusqu'à l'extrémité du jardin. Chaque matin je me mettais en route avec la ferme intention de me rendre jusqu'au bout sans m'arrêter. Mais ces belles résolutions s'envolaient dès les premiers pas: tant de choses nouvelles me retenaient dans des sentiers que j'avais déjà parcourus si souvent . . . et finalement je rentrais au laboratoire sans avoir atteint l'inabordable *ultima Thule*.

A cette heure matinale, ce jardin a un charme tout particulier. Pas un souffle de vent. Parmi les innombrables espèces d'arbres qui font du jardin botanique une forêt touffue, règne une délicieuse fraîcheur. Dans l'atmosphère flotte une vapeur légère qui enveloppe les objets d'une transparente gaze bleue. Et le botaniste émerveillé promène son recueillement entre les orchidées qui épanouissent leurs fleurs, sous les hautes fougères dont les feuilles plumeuses forment une voûte diaphane par-dessus les sentiers.

Regardons autour de nous, et admirons. Admirons les papillons aux mille nuances dont les ailes satinées frôlent les aiguillons des rotans; brusquement ils se posent, et les brillantes couleurs qu'ils étalaient pendant leur vol capricieux sont à présent si bien cachées, leur teinte s'harmonise si complètement avec celle des écorces et des feuilles sèches, que ce serait perdre son temps que de les chercher. Suivons des yeux les superbes bourdons violets à reflets irisés qui volent lourdement de fleur en fleur, se chargent de leur pollen, et les fertilisent. Des libellules rouges, vertes, ou brunes, planent au-dessus des nénuphars roses et bleus. Les fourmis affairées se hâtent de faire leur récolte de nectar et vont visiter les pucerons et les cochenilles qu'elles entretiennent sur les feuilles; des fourmis-soldats se promènent nonchalamment et agitent leurs formidables mâchoires comme pour dire aux ouvrières: "Ne craignez rien; nous faisons bonne garde."

Il est dix heures. Nous sommes déjà trop longtemps restés au soleil. Mais avant de retourner au laboratoire, demandons à l'un ou l'autre jardinier indigène les noms des fruits et des plantes en germination que nous avons ramassés sous les arbres et dont nous ignorons la provenance précise. Pendant les premiers temps de son séjour à Buitenzorg, le botaniste est complètement dérouté par la façon plus que fantaisiste dont les Malais prononcent les mots latins, et il doit régulièrement leur demander d'écrire les noms. En effet, les sons *u*, *eu*, *f*, *v*, *z*, etc., manquent à leurs langues;[5] de plus, ils ne prononcent jamais deux consonnes de suite au commencement ou à la fin d'une syllabe, et déplacent fréquemment l'accent tonique. Chez eux, *Ficus* devient *Pikís*, — *Uvaria*, *Iparíz*, — *Stephania*, *Setepanía* . . .

Dès qu'on s'est familiarisé avec cette prononciation, on a grand plaisir à consulter les jardiniers. Les chefs-ouvriers connaissent le nom latin et les noms vulgaires (malais et soendanais) de toutes les plantes qui sont cultivées au jardin et de la plupart de celles qui croissent spontanément aux environs. Ces Malais sont à tous points de vue des systématistes surprenants. Ils ont dans leurs langues des noms pour presque toutes les espèces, même pour celles qui ne présentent aucune utilité. Ce n'est pas eux qui con-

[5] Dans la région occidentale de Java (donc à Buitenzorg), on parle soendanais; dans la région moyenne, javanais; à l'extrémité orientale, madourais. Quant au malais, il n'est parlé comme langue maternelle que par quelques milliers d'habitants de la côte septentrionale. Seulement comme toute l'administration de l'île se fait en cette langue, c'est elle qui est enseignée dans les écoles; tous les habitants quelque peu lettrés, — et ils sont très nombreux, — s'en servent couramment. Le malais est d'ailleurs l'une des langues les plus importantes du globe, car elle sert aux relations commerciales des côtes de toute l'Indochine, de l'Insulinde, des Iles Philippines, de la Nouvelle-Guinée, de la Micronésie et d'une grande partie de la Polynésie. On la parle même à Ceylan.

fondraient sous le nom de "fleurs de beurre," des renoncules et des potentilles. Le moindre coolie que vous prenez au coin de la rue pour porter l'appareil photographique, pendant une herborisation, vous ravit et vous humilie du même coup par la sûreté avec laquelle il distingue des espèces voisines, à peine différentes.

Nous voici au quartier des laboratoires. Le volumineux bouquet de plantes rares que nous avons cueilli pendant la promenade est éparpillé sur les tables. La plupart des espèces sont remises au garçon de laboratoire, un Javanais soigneux et patient qui les étale et les presse entre des feuilles de papier pour les sécher au soleil. D'autres sont conservées dans l'alcool et vont s'entasser dans de grands flacons. Enfin, il en est beaucoup qui doivent être immédiatement étudiées. Mais avant de nous mettre à les débiter en coupes minces, jetons un regard sur ce que nous apportent ces enfants, rangés en une longue file. Les plus petits sont nus; ceux qui sont un peu plus grands portent une espèce de veste; ce n'est que beaucoup plus tard que les garçons y ajoutent une culotte et les filles une petite jupe. Ils viennent offrir les animaux qu'ils ont capturés: serpents et lézards adroitement pris dans un lacet de bambou, papillons pressés dans un papier replié, coléoptères métalliques et monstrueuses araignées enfermées dans une bouteille d'où l'on a quelque peine à les faire sortir. La plupart de ces jeunes naturalistes ont déjà fait choix d'une spécialité. Il y a, par exemple, une petite fille qui ne recueille que des planaires arboricoles; d'autres, des garçons ceux-là, m'apportent surtout de brillants hémiptères dont l'odeur nauséabonde dépasse tout ce qu'on peut imaginer. Après une ample distribution de *cents* ou même de petites pièces d'argent, la troupe bistrée me souhaite le bonjour "tabeh toewan" et s'en va gambader dans le jardin à la recherche de nouvelles captures.

Un mot encore sur le personnel du jardin. Les ouvriers, au nombre de deux cents, sont tous des Malais. Dans les laboratoires, au musée, à l'herbier, à la bibliothèque et dans les ateliers de photographie, les emplois inférieurs sont également tenus par des indigènes. Parmi eux, il faut mettre hors pair les dessinateurs. Leurs œuvres ont un fini, un scrupuleux souci du détail et une élégance artistique que je n'ai jamais vu dépasser en Europe. Ajoutons immédiatement que les Malais employés à Buitenzorg s'acquittent tous fort bien de leur besogne. Pourrait-il en être autrement de la part d'un peuple intelligent, doux et industrieux, qui ne connaît l'alcool que pour avoir vu des soldats européens en état d'ivresse?

Déjà midi. Il faut rentrer, mais le soleil est trop ardent pour marcher. Faisons chercher une voiture, et pour dix *cents* nous serons cahotés jusque chez-nous. Ces voitures sont de petits dos à dos (les Malais ont contracté ce mot en "sado"), sur lesquels on ne sait quelle position garder pour éviter les courbatures. Oublions un instant notre supplice pour regarder au loin un volcan éteint, le Salak: ce matin la cime se profilait en bleu foncé sur un ciel pâle sans une tache; elle se couronne à présent de gros nuages. C'est l'orage qui se prépare.

La voiture pénètre dans le jardin de l'hôtel et nous dépose devant notre chambre. Dans la véranda qui précède celle-ci, le domestique a étalé nos habits et nos chaussures. Précaution indispensable, car l'air est excessivement humide à Buitenzorg malgré la haute température, et les vêtements qui ne sont pas régulièrement exposés à l'air se recouvrent, en deux ou trois jours, d'une abondante végétation de moisissures.

Avant de nous mettre à table, il ne sera pas inutile de nous laver des pieds à la tête. La promenade de ce matin et le travail au laboratoire nous ont inondés de sueur; les vêtements de coton ou de toile qui étaient si blancs, si proprement empesés au matin, se sont lamentablement fripés, et nous ferons chose sage en les échangeant contre des habits plus présentables.

Le repas de midi se compose invariablement des deux mêmes plats, currie et bifteck.[6] Le premier est du riz cuit auquel viennent s'ajouter d'abord une sauce jaune des plus complexes, puis du poulet préparé de toutes les façons imaginables, des fricadelles (de poulet), des poissons de mer et d'eau douce, des bananes cuites, des condiments pris dans une vingtaine de plats, des légumes de toute sorte, etc., etc. On mélange le tout de façon à en former une mixture homogène. Ce currie (ici on dit *kari*) constitue un excellent plat. On est un peu désorienté seulement, les premiers jours, par la grande quantité de piment et d'épices qui entrent dans sa composition, mais on s'y fait vite.

Après le déjeuner, la chaleur est presque désagréable. Les nuages que nous avons vu s'amonceler autour du Salak ont maintenant envahi tout le ciel. C'est le moment de la sieste; profitons-en. Enlevons les beaux habits blancs que nous avons mis tantôt et étendons-nous sur la chaise longue, ou mieux encore sur le lit. Au bout de peu d'instants, on se met à rêver à des fleurs grandes comme des maisons et à des insectes dont l'odeur renverserait un bœuf, et l'on est bientôt profondément endormi. Comme cette sieste est douce et reposante! On irait vivre sous l'équateur rien que pour pouvoir dormir ainsi au milieu du jour, sans se faire remarquer. Lorsque, un peu avant trois heures, le garçon vient apporter le thé, les fatigues du matin sont complètement oubliées et l'on peut se remettre au travail.

En général, l'orage a déjà éclaté en ce moment. Choisissons un jour où l'averse est plus tardive et rendons-nous au jardin botanique. Les rues si animées ce matin, sont vides à présent; chacun est retiré chez soi. Il fait un calme surprenant dont rien en Europe ne peut donner une idée. Les grandes palmes luisantes des cocotiers pendent immobiles dans l'atmosphère lourde et chaude. Par instants le soleil frappe les feuilles laquées des arbres-à-pain qui se détachent alors avec violence sur le fond noir du ciel. A peine reste-t-il des fleurs. Les nénuphars et les ipomées, si éclatantes au matin, sont déjà refermées et flétries; d'ailleurs les papillons et les bourdons ont également disparu. Par contre, les fleurs nocturnes ne tarderont pas à s'épanouir; nous verrons les lobes de leur immense corolle se déplier pour laisser passer les étamines et les stigmates. Les papillons de nuit peuvent venir: quand ils dérouleront leur trompe jusqu'au fond de la corolle, ils déposeront le pollen dont leurs ailes se sont chargées ailleurs.

Les premières gouttes de pluie. C'est le moment de jeter sur nos frais habits blancs le grand imperméable de caoutchouc. En un clin d'œil, les sentiers du jardin sont devenus des torrents écumants. Le tonnerre, répercuté de volcan à

[6] Les Malais prononcent *bipesetik*, du hollandais *biefstuk*.

volcan, gronde sans un instant de répit et accompagne de sa basse profonde le crépitement métallique de la pluie sur les feuilles de palmier. Nous n'avons rien à craindre: les hauts cocotiers qui nous entourent nous protègent contre la foudre. Continuons notre tour. Au surplus, il fait trop sombre et trop étouffant pour travailler au laboratoire. Qui oserait entreprendre de décrire la violence de ces averses équatoriales? Contentons-nous de dire que nous avons vu tomber à Buitenzorg, en deux heures, $0^m,14$ de pluie, c'est-à-dire le cinquième de la quantité totale qui tombe en une année en Belgique.

Soudain la pluie cesse. Nous pouvons maintenant circuler sous les arbres, sans notre imperméable; car si les arbres d'ici ne protègent pas contre la pluie, au moins, dès que le beau temps est revenu, n'arrosent-ils plus le promeneur.

Au bout de cinq minutes, le ciel est redevenu bleu, ne gardant que tout juste assez de nuages pour nous donner tantôt un brillant coucher de soleil. Le calme est encore plus profond qu'avant l'orage. Le seul bruit qu'on perçoive de loin en loin vient d'une cigale qui accorde sa lyre.

Rentrons chez nous par le Pekantjilan, une gorge escarpée bordée de palmiers et de puissantes gerbes de bambou, au fond de laquelle la rivière, si paisible ce matin, roule maintenant des flots tumultueux. A droite du Salak, le soleil se couche majestueusement derrière un amoncellement fantastique de gros nuages frangés de teintes changeantes. Plus brillants encore, sont les jeux de couleurs qui se succèdent sans interruption dans les nuages posés sur l'horizon à gauche du Salak, entre cette montagne et la grande chaîne de volcans à laquelle appartiennent le Gedeh et le Pangerango.

Le soir tombe vite. Déjà nous apercevons de toutes parts de minuscules lumières tremblotantes; les marchands postés aux accotements de la rue ont allumé leur veilleuse à l'huile de coco. Ils vendent surtout des fruits, des sucreries, des limonades. D'autres installent sur la voie publique de petits restaurants portatifs, où l'on consomme des pâtisseries faites à l'huile de coco, ou du riz cuit, gentiment enveloppé dans une feuille de bananier. Les échoppes de fruits et de limonades se composent tout uniment de deux corbeilles en bambou; la journée finie, le propriétaire les attache aux extrémités d'un bambou qu'il pose sur son épaule. Les restaurants se transportent de la même façon: à l'un des bouts du bambou, le foyer tout allumé et la casserole fumante; à l'autre, les produits de la fabrication. C'est un curieux spectacle, le soir, celui de ces petites cuisines balançantes qui se promènent, laissant derrière elles, dans l'atmosphère calme et sereine, une traînée de fumée et une odeur d'huile de coco brûlée. Le Javanais vit très peu chez lui; toute la journée il est dehors, mangeant le long du chemin: pour quatre ou cinq *cents* de riz, un verre de limonade d'un *cent*, quelques fruits, bananes, mangues ou ananas (ceux-ci coûtent de deux à trois *cents*, suivant la grosseur); il ne lui en faut pas davantage.

Nous voici rentrés. A Java, les hôtels portent presque tous des noms français; ceux de Buitenzorg, par exemple, s'appellent *Hôtel du Chemin de Fer*, *Hôtel Belle-Vue*, *Hôtel de l'Europe*. C'est dans le premier que nous logeons. Au milieu se trouve la salle de réunion et la salle à manger. Tout autour du bâtiment central s'étend un jardin, et le long de trois de côtés de celui-ci sont les chambres. Ces dernières, qui sont toutes au rez-de-chaussée, — il n'y a jamais d'étage aux maisons, — s'ouvrent sur une véranda où chaque pensionnaire possède une table, une chaise longue et deux fauteuils. La chambre elle-même est très grande et bien aérée; le lit est à lui seul beaucoup plus spacieux que toute la cabine que j'occupais à bord, quoique, en ma qualité de médecin, j'eusse une cabine spéciale.

Nous ne resterons dans la chambre que le temps d'ôter nos vêtements empesés pour nous mettre en négligé: une chemise, un léger pantalon, une veste lâche et une paire de babouches chinoises; voilà tout l'accoutrement. Il est heureux que le costume soit aussi peu compliqué, sinon la moitié de la journée serait employée à se déshabiller et à se rhabiller. Chacun vient maintenant s'asseoir à la véranda. On se fait visite de l'un à l'autre. Quelles bonnes longues causeries nous avons faites ainsi le soir avec le camarade HALLIER, assistant au jardin botanique, et M. le professeur POULSEN, de Copenhague, qui occupaient des chambres voisines de la mienne!

Pendant que nous sommes tranquillement assis, devisant de choses et d'autres, les animaux nocturnes font leur apparition. C'est d'abord le tjitjak, un mignon lézard qui court sur les murailles et contre le plafond à la poursuite d'insectes. Ceux-ci ne manquent pas, et à certains soirs, on est presque aveuglé par les mâles de fourmis et de termites qui viennent voltiger en nuées compactes autour de la lampe (une lampe "Belge" achetée dans un magasin de Buitenzorg). Le tjitjak ne chôme pas un instant; c'est merveille de voir avec quelle adresse il parcourt la muraille pour darder sa langue sur les insectes. Des chauves-souris volent sans bruit dans la galerie; chaque fois qu'elles passent devant nous, elles font quelques circuits autour de la lampe pour avoir leur part du butin. Dans le jardin, devant la véranda, les rousettes (immenses chauves-souris frugivores) se transportent, tout aussi silencieusement, d'un arbre fruitier à l'autre.

Souvent, mon protégé le crapaud vient me faire visite; il se place contre le pied de ma table et s'annonce par quelques coassements amicaux. Il me connaît bien et sait que je le soigne comme un fils. A chaque insecte que je laisse tomber près de lui, le batracien se traîne avec précaution vers la victime et la regarde attentivement. Dès qu'elle risque de remuer une patte ou une aile, on entend un petit claquement: le crapaud a lancé sa langue sur la petite bête. Il me jette alors un long regard de reconnaissance, — du moins, j'ai plaisir à croire que son œil exprime de la gratitude, — puis il se tord l'abdomen et agite un orteil. Lorsque je froisse les insectes entre les doigts de façon à les tuer complètement, mon ami se dirige encore vers eux et les examine quelque temps; mais quand il constate qu'ils ne bougent pas, il fait le dégouté et s'en va. Comment donc a-t-il appris à se défier des proies mortes, qui sont peut-être en état de décomposition? Ce n'est certes pas par le goût ou par l'odorat qu'il a pu faire son éducation, car il avale goulument des insectes vivants que j'ai trempés un instant dans le pétrole. Quoi-qu'il en soit, l'observation fait voir combien il est utile pour les insectes de savoir faire le mort. Nous pouvons aussi nous rendre compte de la crainte salutaire qu'inspirent les ouvrières de fourmis. Le crapaud mange volontiers les mâles, mais quand c'est une ouvrière qui passe à côté de lui, il la considère un mo-

ment et la laisse tranquillement vaquer à ses affaires.

Un coup de cloche: on s'habille pour le dîner. Cette fois-ci, c'est plus sérieux; il faut se déguiser en Européen: chemise amidonnée, col, cravatte, manchettes, veston noir, en un mot tout cet équipement ridicule et encombrant qu'il serait si bon d'oublier.

Les convives réunis à table d'hôte, devant un repas dont le menu est dressé en français, ont un air jovial et bien portant qui fait plaisir à voir. Chaque pensionnaire est flanqué de son domestique malais qui change les plats, verse à boire, met de la glace dans les verres, avance les condiments, etc.

Après le dîner nous faisons parfois une courte promenade dans Buitenzorg; on patauge, il est vrai, dans une épaisse boue noire, mais les soirs de lune, le spectacle ne laisse pas d'être fort attrayant. En général, pourtant, chacun rentre dans sa chambre; couvert à présent d'une simple chemise de flanelle et d'un sarong (une sorte de jupe), on s'occupe à lire ou à écrire, tandis qu'au dehors, au milieu des fleurs et des palmiers, les grillons et les cigales font un strident concert. A chaque heure, les veilleurs frappent de toutes leurs forces sur une grosse cloche de bois et se répondent d'un hameau à l'autre.

Il est temps de se coucher; écartons légèrement le moustiquaire qui entoure entièrement le lit. Les fenêtres ouvertes laissent entrer les senteurs de la nuit, pendant que nous dormons en paix. Demain nous recommencerons la même existence calme et heureuse, exempte de soucis et remplie de merveilles.

### DANS LA FORÊT VIERGE:—

Au triple galop de nos petits chevaux javanais, nous roulons de grand matin vers le Salak.

Dans les rizières qui étalent jusqu'à l'horizon leurs terrasses inondées, des femmes vêtues d'un simple sarong, les pieds dans l'eau, repiquent les plants de riz élevés en pépinière. Ailleurs nous les voyons occupées dans la véranda de leur coquette maison de bambou, tandis que les enfants, tout nus, prennent leurs ébats parmi les fleurs et les brillants feuillages du jardinet, à la poursuite des papillons. Dans tous les ruisseaux — et ils sont nombreux — des lavandières battent les vêtements de leur famille sur les grosses pierres arrondies qui, aux heures de crue, se détachent des volcans voisins et roulent jusqu'ici. En mères prudentes, elles surveillent les bambins qui font des sauts de carpe au plein milieu de la rivière ou, pêle-mêle couchés sur la berge, se tressent des couronnes de fleurs.

Comme la population est dense! Les villages succèdent aux villages, tous blottis sous les arbres fruitiers, parmi les puissantes gerbes de bambou dont les tiges, serrées à la base, jaillissent tout droit, comme un bouquet de feu d'artifice, puis se penchent et se recourbent gracieusement, bien haut dans le ciel. Et le long de la route c'est une procession ininterrompue de gens qui se dirigent vers le "passăr Bogor" (bazar de Buitenzorg) pour y vendre des fruits et des légumes. Au bambou que est porté sur l'épaule sont attachées deux corbeilles remplies de pamplemousses, d'ananas, de mangues, de sapotilles, de mangoustans, de ces mille fruits succulents dont le nom même est ignoré en Europe.

La carriole s'arrête à Soekamantri, à la base du Salak. La route cesse ici et nous gravissons à pied les premières pentes du volcan. Le sentier nous mène au travers des plantations de caféiers et de muscadiers, puis parmi de hautes herbes, toutes ruisselantes encore de l'averse d'hier.

Devant nous s'ouvre la large solution de continuité dans laquelle nous allons entrer. Elle a été produite en 1699, lors de la dernière éruption du Salak.[7] L'explosion eut une telle violence que tout un pan de la montagne fut lancé dans les airs et éparpillé au loin, créant ainsi une immense déchirure. Toute la pluie qui tombe dans l'entonnoir, large de plus de deux kilomètres, se déverse au dehors par cette fente. Le Tjiapoes, ainsi se nomme le torrent qui roule au fond de la gorge créée par le cataclysme de 1699, est presque à sec pendant la majeure partie de la journée; mais chaque après-midi il est gonflé par l'orage et fait alors écouler en quelques heures la masse liquide qui se précipite dans le vaste entonnoir.

Le lit du Tjiapoes est tellement obstrué par les gros blocs roulés qu'on ne peut pas songer à le suivre. Heureusement qu'on a creusé sur l'une des pentes de la gorge une dérivation destinée à alimenter des rizières situées en contre-bas. Presque partout on peut cheminer sur la berge du petit canal; ailleurs on n'a qu'à marcher dans le ruisselet même.

Engageons-nous dans la gorge. Dès les premiers pas, nous nous arrêtons ébahis, ravis en extase devant le spectacle prodigieux que nous offre la forêt vierge. La forêt vierge! Songez donc à toutes les émotions que ce seul mot fait naître dans le cœur d'un botaniste. Et la réalité est incomparablement plus belle que tout ce que peut rêver l'imagination la plus fertile.

Nos langues européennes sont impuissantes à exprimer cet enchevêtrement. Elles ne contiennent en effet que les mots qui se rapportent aux choses d'Europe; et, comparées au moindre taillis des régions équatoriales, les forêts européennes les plus touffues paraissent vides et nues. Par quel prodige nos langues contiendraient-elles les mots qui correspondent à un pareil fouillis? Au lieu de nos troncs nus, dressés côte à côte sur un sol qui porte à peine quelques misérables herbes, nous nous trouvons devant un inextricable pêle-mêle de végétaux, remplissant tout l'espace qui est compris sous la cime des arbres. Pas de vides ici, comme dans le sous-bois des forêts d'Europe. La terre, on ne la voit pas, couverte qu'elle est d'un épais manteau d'herbes de mille espèces. Les troncs des arbres disparaissent derrière les lianes et les plantes épiphytes. A quelle hauteur se dresse la muraille de rocher, au pied de laquelle glisse le ruisseau que nous suivons? Impossible d'en rien dire; le rideau de feuillage est tellement dense que le regard porte à peine à deux ou trois mètres. Des arbres de toute sorte sont accrochés à la parci de pierre. Parmi leurs racines, les mousses forment d'épais coussinets. Des fougères fines et transparentes recouvrent les mousses d'une légère gaze verte. D'autres fougères laissent gracieusement retomber des feuilles pâles, longues de plusieurs mètres. De mignonnes orchidées, piquées dans les pelotes de mousse, nous font admirer leurs feuilles satinées, veinées de délicats filets d'or et d'argent. Que sont les fleurs à côté de pareils joyaux! Mais à peine cette exclamation nous a-t-elle échappé que nous nous émerveillons devant de splendides fleurs rouges qui éclatent sur une liane cramponnée au rocher. Tout contre la base de la muraille, de minuscules plantes luisent dans l'ombre; leurs cellules, en forme de lentille, concentrent les faibles rayons lumineux qui filtrent jusqu'à elles.

Sous nous, les éboulis dont nous suivons la crête, portent la même végétation follement exubérante. Par places, une éclaircie créée par la chute d'un arbre nous permet de voir l'autre versant de la gorge. La paroi est à pic, comme de notre côté, et la roche ne s'aperçoit nulle part, pas plus qu'ici. Des arbres sont installés sur toute la hauteur de la muraille. Des lianes, venues on ne sait d'où, grimpent dans les cimes des arbres, les enlacent en tous sens, filent d'une masse de feuillage à l'autre, et finalement s'épanchent en longs festons, comme en un ruissellement de fleurs.

PAÏDAN[8], armé de son grand couteau de jungles, nous ouvre péniblement un sentier. Il est suive de près par mon camarade HALLIER, qui a exploré pendant huit mois les forêts de Bornéo, et est quelque peu blasé sur les beautés de la forêt vierge. Quant à moi, je traine généralement bien loin en arrière, perdu dans la contemplation d'une fougère arborescente dont l'élégant parasol de feuilles plumeuses vibre sous les bouffées de vent que nous envoie le cratère, ou devant un coin de forêt où les lianes, les épiphytes, les orchidées, les grandes feuilles colorées des herbes, les fleurs de toutes nuances forment un décor de féerie. Alors j'appelle auprès de moi le coolie qui porte l'appareil photographique. Hélas! lorsque je développai les plaques à

[7] On croyait le Salak complètement éteint depuis lors. Mais, dans ces dernières années, son activité s'est réveillée et un cratère de boue s'est formé au milieu des plantations qui revêtent les versants du volcan.

[8] PAÏDAN est un jardinier de Buitenzorg qui, depuis de longues années, accompagne dans leurs excursions les visiteurs étrangers du jardin. Il sait très bien tout ce qui intéresse les botanistes et, pendant les herborisations, aucune plante remarquable ne lui échappe.

Buitenzorg, je constatai à mon grand désespoir qu'à peine une ou deux, faites dans des clairières, valaient la peine d'être conservées. Les autres ne montraient qu'un fouillis confus et inexplicable de feuilles et de tiges. Plus tard, pendant un séjour de cinq semaines que j'ai fait dans la forêt vierge de Tjibodas, j'ai pu me rendre compte de l'extrême difficulté que présente la photographie dans la forêt équatoriale. La lumière est si faible que les plaques instantanées doivent être exposées de huit à douze secondes. Encore la photographie n'est-elle possible que dans les clairières; et après une longue suite d'insuccès, on n'essaye plus de faire tenir sur une plaque de quelques centimètres la profonde forêt vierge, avec son infinité de plans.

Nous arrivons à une petite terrasse. Ici les arbres sont plus hauts et le bois devient plus dense encore. HALLIER tire d'un étui un instrument qu'on ne s'attendrait pas à voir entre les mains d'un botaniste: des jumelles. Il explore attentivement la cime des arbres, pour chercher d'où viennent les fleurs répandues sur le sol. Il les découvre enfin sur un arbre fixé dans la paroi de rocher. Aidé de PAÏDAN et du coolie, il se met à grimper jusqu'à elles.

Pendant que je reste seul, je contemple la forêt qui m'entoure. Quelle variété parmi ces arbres! Il n'y en a pas deux qui se ressemblent, et malgré cela, leurs limites sont indistinctes. C'est comme si l'on passait par des gradations insensibles d'une cime à l'autre. Les arbres ont perdu leur personnalité; il n'y a plus d'individus; il n'y a qu'une forêt indivise dont chaque arbre semble un organe . . . et les lianes établissent d'innombrables connexions entre ces organes. Elles s'élancent dans toutes les directions, s'amarrent à une grosse branche, retombent par terre, montent vers de nouveaux supports, suspendent d'un arbre à l'autre des guirlandes de verdure et de fleurs, glissent encore une fois dans l'herbe, regrimpent jusque tout en haut pour passer sur d'autres cimes, et, tendues comme des câbles ou pendant mollement en longues franges fleuries, relient l'ensemble des arbres en un tout continu. Des fougères, des orchidées, mille et une plantes merveilleuses ont élu domicile sur les grands végétaux. Installées sur les plus minces brindilles aussi bien que sur les troncs, elles comblent tout l'espace qui restait libre entre les arbres.

La lutte pour l'existence est ici plus âpre que partout ailleurs. Nombre d'espèces ont dû quitter le sol, où elles se trouvaient en conflit avec trop de compétiteurs, et chercher un asile dans la couronne des arbres. D'autres sont devenues des lianes; celles-ci ont renoncé à fabriquer un tronc résistant et, pour atteindre à la lumière, elles se font supporter par des voisins plus vigoureux. Ce n'est pas tout encore. Dans cette forêt, dense au delà de toute expression, qui nous donne une si vive sensation de plein, de débordant, il restait encore un emplacement disponible: la surface des feuilles. Une foule de petites plantes s'en est emparée, et ce ne sont pas seulement des mousses et des lichens qui habitent les grandes feuilles luisantes, mais aussi des fougères et des orchidées. Emportons-en quelques-unes pour les examiner au microscope, et nous verrons grouiller, parmi les plantes, tout un peuple d'animalcules, infusoires, rotifères, vers, etc. Une ménagerie au milieu d'un jardin botanique établi sur une feuille!

Par terre, à la place des mousses et des feuilles mortes qui couvrent le sol des forêts d'Europe, nous nous frayons un passage à travers un épais fourré d'herbes. Et quelles herbes! Des fougères avec des frondes hautes de quatre mètres, qui ombragent des arbrisseaux, des bananiers lacérés par le vent, dont les feuilles pendillent en étroites lanières, d'innombrables plantes aux formes étranges, ornées de teintes brillantes, des parasites qui percent à peine le sol et étalent leurs fleurs brunâtres . . . Sur toutes les feuilles, des gouttelettes liquides scintillent comme des brillants. Ce sont ou bien les restes de l'orage de la veille, ou bien des gouttes d'eau sécrétées par les plantes elles-mêmes. Car dans ces couches inférieures de la forêt, où la circulation d'air est très lente, où les rayons du soleil ne percent jamais, l'atmosphère est presque constamment saturée de vapeur d'eau; et les feuilles ne pouvant perdre par transpiration l'eau que les racines absorbent sans cesse dans le sol, sont obligées de s'en débarrasser sous la forme de perles liquides.

Pourtant, cette forêt si extraordinairement serrée ne se présente pas comme un chaos, comme un entassement confus de végétaux. Dans son ensemble, elle a l'air de fonctionner à la façon d'un organisme unique. De même que les divers organes d'une plante, concourant à un but commun, évitent de se nuire, de même il semble que chaque arbre se soit adapté à ses voisins, se soit accommodé à eux, que chacun s'efforce de n'occuper que l'espace laissé libre par les autres. On a l'impression que ces myriades de plantes se sont associées pour exploiter à bénéfice commun le terrain dont elles disposent, qu'elles ont conclu entre elles une entente à l'amiable. Pure illusion! Elles se font une guerre acharnée, elles se livrent une lutte sans trêve ni merci. Voyez cette multitude de jeunes arbres qui languissent et s'étiolent dans une demi-obscurité, étouffés par leurs propres parents. Jetez les yeux sur cette liane enroulée autour d'un tronc; elle l'étreint avec une telle violence qu'elle s'enfonce dans sa chair et qu'elle finit par étrangler son tuteur d'hier, aujourd'hui sa victime. L'arbre sera renversé par le prochain orage; aura-t-il du moins la satisfaction d'entraîner dans sa ruine le parasite qui a causé sa perte? Pas même. Aussitôt par terre, le colosse est condamné, lui; il deviendra la proie des champignons et des microbes; mais la tige souple et flexible de la liane ne souffrira guère de la chute, et dès le lendemain elle étendra ses longs rameaux en quête de nouveaux appuis. Plus tard, lorsque après avoir affamé et vaincu ses concurrents, quelque autre arbre aura pris la place de celui qui s'est écroulé, la liane envahira sa cime et peut-être lui fera subir le même sort qu'à son devancier. Et ces fougères en forme de corbeille, qui se balancent comme des fleurs gigantesques sur les lianes tendues à travers la forêt? Des détritus de toute sorte s'accumulent entre les feuilles pour constituer une réserve d'humus dans laquelle la fougère puise les matériaux de sa nutrition. Les plantes les plus variées ont germé dans cette corbeille, absorbant à leur profit personnel les aliments que la fougère, fondatrice de la colonie aérienne, avait emmagasinés pour elle seule. Petit à petit, le jardin suspendu s'est alourdi, et à présent il suffira d'une averse plus copieuse que d'habitude pour rompre le mince cordon qui supporte la fougère avec tout son cortège de commensaux. Cette existence qui avait débuté là haut, dans les airs, se terminera tristement parmi les herbes.

Non! la forêt vierge n'est pas une association dont les divers membres s'entr'aident. C'est un champ de bataille, un champ de carnage plutôt. Ici comme ailleurs, l'égoïsme, la loi du plus fort dominent tout. Les plantes les moins favorisées doivent céder la place à leurs concurrentes; elles vont s'établir le long des plages vaseuses pour y constituer les mangroves, ces étranges forêts submergées à marée haute; elles se réfugient dans les cratères des volcans, au milieu des exhalaisons sulfureuses; ou bien encore, quittant le sol de la forêt, elles forcent leurs propres vainqueurs à leur prêter un appui: lianes, elles les enlacent de leurs replis, et parvenues au sommet des arbres, elles épanouissent enfin au soleil leurs légions de fleurs; épiphytes, elles s'installent sur les branches, et grâce à l'extrême humidité de l'atmosphère, s'y développent avec exubérance. Nulle part il n'y a autant de parasites qu'ici; non seulement des lianes et des épiphytes, simples parasites de support, mais des parasites complets, qui sucent dans les racines ou les tiges de leur hôte tous les éléments dont ils ont besoin.

Entre cette multitude de concurrents pressés les uns contre les autres et s'efforçant tous de conquérir une place au soleil, c'est une guerre d extermination qui se poursuit avec acharnement, dans l'ombre, sans trêve et sans éclats; — lutte à outrance, sourde et implacable, dans laquelle tous ont un même but: supplanter les rivaux et défendre contre les assaillants la position durement conquise. C'est un combat incessant, de chaque minute, où la moindre infériorité est fatale, où le plus petit désavantage équivaut à une condamnation à mort, opiniâtre surtout entre individus nés des mêmes parents, ayant donc des besoins identiques et pourvus des mêmes armes. Mais si la lutte est âpre et se poursuit sans relâche, néanmoins elle ne trouble pas le calme de la forêt. Souvent le vaincu reste debout, amarré de toutes parts par les câbles de lianes, et n'est abattu que par un orage, un coup de vent ou une averse torrentielle. Le vide créé par sa chute ne tarde pas à être comblé par les végétaux voisins qui joyeusement poussent de ce côté leurs rameaux et leurs fleurs. Celui qui jette sur la forêt un regard superficiel est saisi par l'harmonie calme et paisible qui s'en dégage; mais que de ruines cachées sous les fleurs; que de cadavres dans lesquels les meurtriers enfoncent leurs racines!

Qui donc a dit qu'il n'y a pas de fleurs dans la forêt équatoriale? Sans doute, dans le sous-bois, les fleurs brillamment colorées sont exceptionnelles; la grande majorité des plantes sont des fougères ou des phanérogames à inflorescences peu voyantes, fécondées par le vent ou par la pluie. C'est que, près de terre, il n'y a presque pas d'insectes capables d'opérer le transport du pollen; aussi, pour attirer les

quelques rares papillons qui se risquent dans le sous-bois sombre et humide, les fleurs qui ont besoin de leur aide doivent-elles se livrer une concurrence acharnée et acquérir des pétales immenses, parés de couleurs éclatantes, qui se montrent de loin comme des étendards. Toutefois, c'est dans la couronne des arbres et non dans le voisinage du sol qu'il faut chercher les brillantes corolles. Ne passons-nous pas à chaque instant à travers de véritables pluies de fleurs qui tombent lentement, comme à regret, et revêtent la broussaille d'un manteau parfumé de pétales? Si même nous ne remarquions pas les fleurs, nous serions avertis de leur présence par un bourdonnement sonore, tombant du haut de l'arbre comme un frémissement de cloche qui s'éteint et se ranime par intervalles. Le son est produit par les milliers d'insectes qui là-haut vont butiner d'une corolle à l'autre. Pas de fleurs dans la orêt! Alors que de Buitenzorg, à plus de douze kilomètres de distance, on reconnaît à leurs myriades d'inflorescences jaunes les bois de teck qui s'étendent à la base du Salak. Pas de fleurs! Et pendant la nuit qui précédait l'arrivée de notre bateau à Padang (Sumatra), nous percevions en pleine mer une pénétrante odeur de fleurs, venue des collines boisées du littoral, non encore visibles au-dessus de l'horizon.

Voici HALLIER et les Malais qui redescendent avec une ample moisson de plantes rares. Pour n'avoir pas à les porter pendant toute l'excursion, PAÏDAN en fait un gros amas qui sera repris au retour. Tout le long du chemin nous avons déposé ainsi, en bottes, les échantillons que nous avons récoltés.

Nous nous faufilons de nouveau parmi les troncs, les herbes, les lianes et les racines enchevêtrées. Aux obstacles que nous oppose la végétation, obstacles dont le couteau de PAÏDAN a facilement raison, s'ajoute maintenant la difficulté de trouver un sentier praticable parmi les rochers éboulés de la paroi.

Tout à coup, nous débouchons dans le lit du Tjiapoes. La gorge s'est élargie et nous voyons à présent toute l'étendue de l'ancien cratère. La forêt dévale jusque tout contre le torrent, et des lianes viennent s'accrocher aux gros blocs, polis par le passage incessant des eaux. Des arbres ont été entraînés dans le Tjiapoes par les éboulements et, couchés sur le flanc, portent encore une abondante flore d'épiphytes.

Laissons planer le regard sur la forêt. Quelle richesse de tons; quelle variété de formes! Des fougères en arbre, légères comme des dentelles; des rotans qui balancent dans un rythme très lent leurs longs fouets garnis d'aiguillons crochus; des feuilles laquées qui miroitent au soleil; des lianes fleuries qui emprisonnent comme dans un filet tout un groupe d'arbres; çà et là, perçant l'ondoyante étendue verte, quelque colosse qui se dresse par dessus ses voisins.

On imaginerait volontiers qu'elle est vieille comme le monde, cette forêt, qu'elle est restée immuable depuis les temps les plus lointains; que, dès le commencement des âges, elle fut comme nous la voyons maintenant. Détrompons-nous. Il n'y a pas même deux siècles, rien de tout ceci n'existait. A la place qu'occupent ces masses profondes de verdure s'ouvrait un gouffre de feu, un cratère qui vomissait des nuages de fumée, dont la seule haleine asphyxiait tout l'entourage, et qui éclata dans un dernier paroxysme de rage, détruisant tout et se détruisant soi-même, pour permettre enfin à la végétation toute-puissante de s'établir en ces lieux où l'activité souterraine s'était seule manifestée jusqu'alors.

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Pourquoi donc parle-t-on toujours de la luxuriante végétation *tropicale*? En réalité, rien ne ressemble moins aux forêts de la zone équatoriale que les déserts qui étalent leur nudité sous les tropiques.

Les vents alizés puisent au niveau des tropiques d'énormes masses de vapeurs qu'ils entraînent vers l'équateur. Ici les deux courants aériens, — celui qui vient de l'hémisphère septentrional et celui de l'hémisphère austral, — se heurtent et s'élèvent vers les hautes régions de l'atmosphère. Pendant ce mouvement ascensionnel, les nuées se refroidissent, la vapeur d'eau se condense et se précipite en violentes averses. Il en résulte qu'au voisinage des tropiques, les pluies sont extrêmement rares, ou même inconnues,[9] tandis que sous l'équateur elles sont très intenses et presque quotidiennes.

Or, la fréquence des pluies joue dans la constitution du climat un rôle aussi important que la chaleur. Il n'y a donc pas lieu de s'étonner si à la sécheresse de l'atmosphère tropicale correspond l'aridité du sol, et si ces pays, déshérités sous le rapport de la pluie, sont uniquement occupés par des déserts: sous le tropique du Cancer, le Nouveau-Mexique et le Texas, le Sahara, l'Arabie, le Nord de l'Inde, — sous le tropique du Capricorne, le désert d'Atacama et le Gran-Chaco, le Kalahari, l'Australie. Près de l'équateur, par contre au sein d'une éternelle moiteur chaude, la terre est entourée d'une ceinture d'opulentes forêts: la région de l'Amazone, celle du Congo et du Haut-Nil, la partie méridionale de l'Inde anglaise, la Malaisie, la Nouvelle-Guinée disparaissent sous la verdure.

C'est dans ces pays privilégiés, où chaque jour le soleil arrive au zénith, où chaque jour aussi la pluie fécondante tombe à torrents, que la vie végétale atteint son apogée. Dès que le sol est livré à lui-même, il donne naissance à une forêt. Les arbres surgissent partout: sur les plages vaseuses, où ils constituent jusque fort avant dans la mer des îlots battus de tous côtés par les vagues; dans les larges plaines marécageuses, inondées à chaque crue; contre les parois des ravins creusés par les torrents; sur les hautes cimes que baignent les nuages . . . Jusque dans les cratères, entre les lacs de boue fumante, la forêt prend possession d'un sol surchauffé, sans cesse bouleversé par les forces intérieures; elle ne recule et ne cède que devant les exhalaisons sulfureuses.

Hélas! non. Les vapeurs méphitiques des volcans ne sont pas ses ennemis les plus redoutables. La forêt recule aussi devant l'homme, l'homme inapte à créer, mais si âpre à détruire. Déjà le grand manteau forestier qui, au début, recouvrait tout Java a été en grande partie déchiré pour faire place à des cultures, et il n'en persiste plus que des lambeaux épars. Dans les plaines on a établi des rizières et des plantations de canne à sucre ou de tabac; plus haut, la forêt vierge, enchevêtrée et débordante, est remplacée par des caféiers et des arbustes à thé alignés en longues files régulières; plus haut encore, les quinquinas élaborent leurs alcaloïdes parmi les souches à moitié carbonisées des occupants légitimes du sol. Le botaniste qui veut voir la forêt vierge doit aller en chercher les derniers débris dans les gorges abruptes, contre les versants inaccessibles, sur les collines calcaires fissurées, qui se sont montrées rebelles à toute culture.

Mais ce n'est pas seulement par des dérodages en masse que l'homme s'applique à anéantir les espèces végétales. L'exploitation avide et imprévoyante à laquelle il soumet les végétaux utiles, provoque la disparition des nombreuses espèces, qui livrent l'un ou l'autre produit industriel. Aussi les arbres qui fournissent la gomme-dammar, la gutta-percha, le camphre de Borneo, et bien d'autres, sont-ils voués à l'extermination prochaine.

Pis que cela! Les grands horticulteurs d'Europe envoient dans les pays équatoriaux des gens qui ont pour mission de dépouiller ces régions de leurs plus belles orchidées. Tout arbre sur lequel vit un exemplaire de l'orchidée convoitée est aussitôt jeté par terre avec tout son cortège d'épiphytes et de lianes. Bien souvent, l'arbre ne porte que des orchidées sans valeur et a été immolé en pure perte. Mais qu'importe pour le collecteur: les prix fabuleux que ces plantes atteignent sur le marché européen ne compensent-ils pas la destruction de quelques milliers d'arbres? Vous qui admirez en Europe leurs fleurs bizarrement tourmentées, dites-vous que chaque échantillon a coûté la vie à une demi-douzaine d'arbres et que peut-être ces orchidées ont été arrachées jusqu'à la dernière plante, que plus jamais un botaniste ne pourra les étudier dans leur milieu naturel. Ceci n'est pas de l'exagération. Certaines espèces américaines, — très rares, et partant très recherchées, — sont déjà introuvables dans leur pays d'origine. A l'heure actuelle, les plus brillantes parmi les orchidées javanaises, les *Vanda* et les *Phalaenopsis*, ont complètement disparu des provinces septentrionales; dans les forêts que j'ai parcourues, je n'en ai jamais rencontré un seul individu. Les *Aerides virens* qui, il y a peu d'années, étaient encore extrêmement abondants dans les environs de Batavia, se sont tous réfugiés maintenant sur quelques arbres isolés, que les traditions populaires protègent contre le pillage. Si les orchidées conservent leur vogue actuelle, le moment n'est pas éloigné où, pour satisfaire la vanité de quelques riches particuliers, toutes les plus belles espèces ne vivoteront plus que dans les serres d'Europe. Nous devons applaudir à la décision prise par ce radjah de l'Indo-Chine qui a défendu aux collecteurs d'orchidées l'entrée de ses États. Pourquoi chaque pays ne protégerait-il pas ses richesses végétales, au même titre que

[9] Dans le Sahara, il y a souvent des périodes de plusieurs années sans une ondée. N'est-ce pas aussi la sécheresse persistante de l'air qui conserve les épaisses couches superficielles de nitrates dans les déserts du Pérou et de la Bolivie, et qui permet d'y construire les maisons avec des blocs de sel?

l'Italie veille à l'intégrité de ses trésors artistiques?

Telle est la puissance de la végétation équatoriale que tout champ inculte se garnit aussitôt d'herbes et de jeunes arbres issus des graines que le vent et les oiseaux apportent d'ailleurs. Mais encore une fois, l'homme intervient, et, sans aucune utilité réelle, il allume périodiquement l'incendie des grandes herbes. Le résultat se devine: les graminées résistent à la conflagration grâce à leurs puissants organes souterrains, tandis que les jeunes arbres sont rôtis et totalement détruits. Et il se constitue ainsi, à la place du jeune bois qui ne demandait qu'à pousser, une brousse impénétrable et tenace qu'il n'est plus possible de défricher.

La suppression d'une forêt dans les régions équatoriales a des résultats bien plus néfastes que dans les pays tempérés. En effet, l'une des caractéristiques de ces forêts, aussi bien en Amérique et en Afrique que dans l'Insulinde, consiste dans l'extrême variété des plantes qui les composent. Rien n'est plus rare que de trouver dans le voisinage d'un arbre quelconque un second individu de la même espèce. A plus forte raison n'y rencontre-t-on pas de grandes étendues occupées par une seule essence, comme c'est le cas pour les futaies d'Europe. Le moyen qu'il en soit autrement! La seule île de Java, grande à peine comme l'Angleterre, compte environ quinze cents espèces d'arbres qui sont en majeure partie endémiques (c'est-à-dire, n'existant que là), alors que l'Angleterre n'en renferme qu'une soixantaine qui toutes se retrouvent ailleurs. Ce qui est vrai pour les arbres, l'est aussi pour les fougères,[10] les orchidées, les lianes, les arbustes, les mille et une plantes qui forment le sous-bois. Une foule d'espèces ne sont connues que sur un seul volcan ou dans une seule forêt. Tout dérodage, tout déboisement, même s'il ne s'opère que sur une région peu étendue, amène à coup sûr l'extinction totale et irrémédiable de plusieurs espèces. Pour ne citer qu'un exemple: une graminée fort curieuse, l'*Isachne pangerangensis*, n'existe au monde entier qu'au sommet d'un volcan éteint, le Pangerango; et elle n'est pas fort abondante: je n'aurais pas pu en récolter un millier d'exemplaires. Qu'on fasse subir une transformation au plateau, grand de quelques ares seulement, qui occupe le sommet de la montagne, et voilà une espèce qui disparaît.

Certes, la majorité de ces plantes ne présente pour l'homme aucune utilité pratique. Mais en sont-elles moins intéressantes pour cela? Le naturaliste ne déplore pas davantage l'extinction d'une liane à caoutchouc que celle d'une herbe intime dont l'étude lui eût peut-être permis d'élucider bien des points obscurs. L'importance d'un organisme se mesure-t-elle à sa valeur industrielle? C'est comme si l'on prétendait que les recherches des astronomes sont vaines et sans intérêt, et que la première pile électrique n'était qu'un jouet, puisque les expériences de VOLTA ne lui ont fait découvrir ni le téléphone, ni la lumière électrique . . . La science se contente de chercher la vérité; si le vrai peut être rendu utile, tant mieux; mais le bénéfice à réaliser n'en est pas moins l'accessoire.

Des milliers d'espèces ont déjà péri, sans aucun doute, dans le vaste dérodage dont Java a été le théâtre. Par bonheur, le gouvernement de l'Insulinde a compris le grand intérêt scientifique qui s'attache à la conservation des espèces végétales; il a fait établir des réserves forestières, c'est-à-dire que dans les diverses régions de Java, on a délimité au sein des forêts restantes des territoires dans lesquels aucun changement ne peut être apporté au tapis végétal, où, par conséquent, la forêt vierge se développe librement. Ces réserves sont actuellement au nombre de dix-huit. L'une des plus importantes est la forêt de Tjibodas, qui fait partie du merveilleux ensemble d'institutions botaniques de s' Lands Plantentuin.

La création des réserves présente, outre les garanties de stabilité pour les espèces, un autre avantage dont ceux-là seulement qui ont herborisé dans la forêt vierge peuvent saisir toute l'importance. Nous avons insisté plus haut sur l'inouïe variété des essences dans la forêt équatoriale. Le botaniste qui parcourt une région donnée arrive à chaque instant devant quelque arbre inconnu; seulement celui-ci n'est pas fleuri, ou tout au moins il ne porte pas en même temps des fleurs et des fruits. Comment faire pour en obtenir de bons échantillons pour l'étude? Il serait puéril de se mettre à la recherche d'un individu fleuri de la même espèce, car on sait d'avance qu'il faudra peut-être dépenser un jour entier sans même qu'on soit assuré du succès. Dans les réserves, les difficultés s'aplanissent. Il suffit de numéroter un exemplaire de chacun des arbres qui se rencontrent dans les divers territoires réservés et de se faire envoyer à l'herbier général des échantillons complets des espèces numérotées, au fur et à mesure qu'elles fleurissent et fructifient. En même temps, les arbres peuvent fournir des feuilles, des fleurs, des fruits, du latex, etc., pour des études pharmacologiques et industrielles. Lorsqu'un arbre est représenté par des matériaux d'herbier suffisants, on l'abat après l'avoir bouturé, et on fait des essais techniques avec son bois, son écorce, etc. Notez que toutes ces recherches pratiques s'effectuent sur des plantes parfaitement connues, dont on a pu récolter des graines avec la certitude de ne pas confondre la plante qu'on désire cultiver avec quelque forme voisine dépourvue d'intérêt.

C'est au Jardin de Buitenzorg que se fait, sous la direction de MM. KOORDERS et VALETON, l'étude scientifique de tous les arbres numérotés dans les dix-huit réserves de Java; ils sont au nombre d'environ 3,500. L'herbier forestier de Buitenzorg a une valeur exceptionnelle, puisque tous les échantillons qui sont placés sous un même numéro dérivent d'un arbre unique, seul moyen d'éviter les confusions entre espèces voisines.

Les frais qu'occasionne l'établissement de pareilles réserves sont fort peu importants. Une fois qu'on a tracé les sentiers qui conduisent d'un arbre numéroté à l'autre, il suffit qu'il y ait dans chaque réserve un Malais actif et intelligent pour maintenir les sentiers en bon état et pour récolter les échantillons au moment voulu.

Je ne pense pas que, dans les autres pays équatoriaux, on ait déjà songé à prendre des mesures analogues, quoique le danger soit partout également menaçant. Petit à petit les forêts tombent sous la hache, ensevelissant sous leurs débris une hécatombe d'espèces. Les plantes utiles sont avidement recherchées sans que nul ne songe à remplacer les individus détruits. Chaque année, les indigènes mettent le feu aux herbes de la brousse et tuent ainsi les jeunes arbres qui essayent sans relâche de reconstituer la forêt. Si les gouvernements n'y mettent bon ordre, il ne s'écoulera pas deux siècles avant que de la superbe ceinture de forêts équatoriales, il ne reste plus que quelques pâles photographies et des descriptions plus insignifiantes encore. Et les utilitaires y perdront tout autant que les naturalistes, car chaque déboisement décime les espèces qui sont importantes au point de vue pratique. Qu'on ne l'oublie pas! c'est par miracle que le *Palaquium Gutta*, l'arbre qui produit la meilleure gutta-percha, a été conservé au Jardin de Buitenzorg, alors qu'il était complètement éteint dans sa patrie. Mais, à côté des quelques plantes utiles, qui ont, par prodige, échappé au massacre, combien n'y en a-t-il pas qui sont anéanties sans retour?

[10] Sur un seul cône volcanique, le Pangerango, on a récolté trois cent espèces de fougères.

# WALLACE'S LINE
# IN THE LIGHT OF RECENT ZOOGEOGRAPHIC STUDIES

*by*

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Zoogeography has had a fate very much like taxonomy. It was flourishing during the descriptive period of biological sciences. Its prestige, however, declined rapidly when experimental biology began to come to the foreground. Again as with taxonomy, a new interest in zoogeography has been noticeable in recent years. It seems to me that this revival has had two causes. One is the interest of the student of geographic speciation in the findings of the zoogeographer. A study of past and present distributions yields much information on isolation of populations and on the dispersal of species. It is in this connection that I became interested in zoogeography.

The other reason is the introduction of new methods. The intensive exploration of all corners of the globe during the past fifty years has led to an accumulation of sufficient faunistic data to permit the application of statistical methods. Furthermore, the science of ecology has reached a level of maturity at which it is beginning to affect profoundly zoogeographic methods and principles. It seemed worth while to me to study the controversial and still wide open subject of the borderline between the Australian and Oriental Regions with the help of such modern methods.

A. R. WALLACE, who is generally considered the foremost representative of classical zoogeography, states in his famous essay *On the zoological geography of the Malay Archipelago* (1860): "The western and eastern islands of the archipelago belong to regions more distinct and contrasted than any other of the great zoological divisions of the globe. South America and Africa, separated by the Atlantic, do not differ so widely as Asia and Australia." There is much truth in this statement. Except for bats and a few rodents, the only native mammals of Australia are marsupials and monotremes. These same two groups are entirely lacking in Asia and are replaced by a wide variety of placental mammals, such as monkeys, shrews, squirrels, ungulates, and so forth. An equally pronounced faunal difference exists among birds, insects, and other groups of animals of the two regions.

Australia and Asia are connected by a belt of islands, the Malay Archipelago, and the question naturally comes up as to where in this island region the borderline is to be drawn between these two fundamentally different faunas. After reviewing the zoological evidence known to him, WALLACE (*l.c.*) comes to the following conclusion: "We may consider it established that the Strait of Lombok [between Bali and Lombok] (only 15 miles wide) marks the limit and abruptly separates two of the great zoological regions of the globe." With these words he drew a zoogeographic boundary which was destined to gain fame under the name of its author: "Wallace's Line," a term first used by HUXLEY (1868) (Fig. 69). It runs between Bali and Lombok in the south, then through Makassar Strait between Borneo and Celebes, and finally turns into the open Pacific between Mindanao (Philippines) and the Sanghir Islands. This convenient borderline found quick acceptance in the zoological literature and was without hesitation adopted by nearly all the zoogeographers publishing between 1860 and 1890. SARASIN (1901) and PELSENEER (1904) should be consulted for a historical survey of the earlier literature. The echo in the popular literature of this period was even more enthusiastic. A mysterious line, only 15 miles wide, that separates marsupials from tigers, and honey eaters and cockatoes from barbets and trogons, could not fail to appeal to the imagination of the layman. E. HAECKEL (1893) outdid all his contemporaries by asserting: "Crossing the narrow but deep Lombok Strait we go with a single step from the Present Era to the Mesozoicum."

Statements of such exaggeration call for refutation and shortly after 1890 doubts were expressed more and more frequently as to the validity of Wallace's Line, particularly after the distributional facts became better known. WALLACE himself was much less positive in his later writings. Since then many writers have insisted that Wallace's Line was entirely imaginary (WEBER (1902), PELSENEER (1904), MERTENS (1930), BRONGERSMA (1936), and others). VAN KAMPEN (1909), for example, asserted: "Such a sharp boundary as WALLACE drew it does not exist. Not only is there none where he drew it, but no such line exists anywhere in the archipelago." On the other hand, Wallace's Line has been vigorously defended by such serious authors as DICKERSON *et al.* (1928), RAVEN (1935), and RENSCH (1936). Curiously enough most of the writers on this subject seem to be definitely in one or the other camp, either they are for Wallace's Line or they are against it, and they tend to present their data accordingly. Others treat one aspect only of this diversified problem. An impartial study of the situation is still lacking at the present time.

Actually, a whole complex of questions is involved, of which the following seem to be the most important ones:

(1) Is Wallace's Line the borderline between the Oriental and the Australian Regions, and if not, where is this borderline?

(2) Does Wallace's Line represent the line of a major faunal break, and if this is true, how did such a break develop?

**Is Wallace's Line the Boundary Between the Oriental and the Australian Regions?**—The fauna of the Malay Archipelago was rather poorly known in WALLACE's days. Where he knew 20 species of birds, we now know 120; where he knew 5 species of reptiles, we know 40, and so forth.

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This lack of information caused WALLACE to single out what he considered typical representatives of the respective faunas, and to use the borderline of their ranges as zoogeographic boundaries. The tiger, the squirrels and other mammals go as far east as Bali, but are absent from Lombok. Among birds the barbets (*Capitonidae*) and many other Oriental groups are abruptly brought to a halt by Lombok Strait. The Australian honeyeaters (genera *Philemon* and *Meliphaga*) and the cockatoe (*Cacatua*) reach Lombok, but not Bali. The faunal difference on either side of Makassar Strait is even more striking: A rich Oriental fauna on Borneo and a marsupial (*Phalanger*) on Celebes. It was on the basis of such data that WALLACE came to the conclusion that Lombok and Makassar Straits form the boundary between the Oriental and the Australian Regions.

An analysis of the now available extensive faunal lists does not bear out WALLACE's conclusion. After eliminating a few widespread species, the fauna of each of the islands of the Malay Archipelago can be divided readily into two groups: One consists of western species, that is, species which are derived from the Oriental Fauna, the other of eastern species, that is, such which are derived from the Australian Fauna. In a few species it is apparent that the genus or the family to which they belong was originally of western origin, but that the particular species arrived in the island belt from the east as a descendant of a group of species that was isolated in Australia at an early date. Such secondarily eastern elements, as *Merops ornatus* among the birds, are included with the eastern group. The classification of a few species will always remain open to doubt, but a different decision in these cases would change the percentages only slightly and would not basically affect the following figures. A specialist of a given group usually has no difficulties in deciding which species are Indo-Malayan and which Australian.

*Celebes.* — WEBER (1902), the SARASINS (1901), DE BEAUFORT (1926), STRESEMANN (1939) and other recent authors agree that at least three fourths of the Celebes animals are of western origin. According to RENSCH (1936: 252) the figures are: Reptiles at least 88 per cent, Amphibia 80 per cent and butterflies 86 per cent.

TABLE 1
*Percentage of western and eastern species on Lesser Sunda Islands*

| | REPTILES AND AMPHIBIANS | BIRDS | | CHANGE OF PERCENTAGE IN BIRDS |
|---|---|---|---|---|
| | Western | Western | Eastern | |
| | *Per cent* | *Per cent* | *Per cent* | |
| Bali | 94 | 87.0 | 13.0 | |
| Lombok | 85 | 72.5 | 27.5 | 14.5 |
| Sumbawa | 87 | 68.0 | 32.0 | 4.5 |
| Flores | 78 | 63.0 | 37.0 | 5.0 |
| Alor Group | — | 57.5 | 42.5 | 5.5 |

In birds the figure is slightly lower. Among 74 species of Passerine birds 67.6 per cent are western. The percentage for the old endemics (genera and good species) and for the more recent immigrants is quite similar. There is no doubt, Celebes must be included with the Oriental Region.

*Lesser Sunda Islands.* — Table 1 shows the ratio of the western and the eastern elements on a number of islands (the data of reptiles and amphibians are from MERTENS, 1930; the data on birds are original). RENSCH's (1936) careful analysis shows that the Indo-Malayan element prevails numerically as far east as the islands of the Timor group. This is equally true for flying animals (birds and butterflies) and for flightless groups (mammals, land snails).

The figures in Table 1 permit only a single conclusion: Wallace's Line is not the borderline between the Australian and the Oriental Regions. The first of the questions asked above is thus answered in favor of WALLACE's opponents.

**Does Wallace's Line Indicate a Major Faunal Break?** — The fact that Wallace's Line is not the border between the Oriental and the Australo-Papuan Regions is not the complete answer to our problem. A line which has been defended so vigorously by so many zoogeographers must have some significance. It is worthy of notice that its staunchest defenders were those naturalists who actually studied and collected the animal life on both sides of the line, like DICKERSON and his associates in the Philippines, like RAVEN who repeatedly crossed Makassar Strait in a sail boat from Borneo to Celebes and back, and like WALLACE and RENSCH who crossed back and forth between Bali and Lombok. The actual impressions of these workers are vividly depicted in a quotation from one of RENSCH's books. Arriving on Bali after a prolonged exploration of Lombok, Sumbawa and Flores, he asks himself:

"What about the animal life? Is it really as different from that of Lombok, as has been claimed by so many other travellers? Is the small strait between the two islands actually a sharp faunal division? A strait, which even the *smallest bird could cross without any difficulties?* . . . And the difference is indeed quite extraordinary! Much more conspicuous than I would have ever imagined. As soon as I entered the woods on a small native trail a whole chorus of strange bird songs greets me — in fact, among the real song-[illegible] with [illegible] the islands east of Wallace's Line]. . . . One surprise follows the other. The very species that are most common on Bali, are absent on the islands to the east. The most characteristic bird of these woods is a green barbet . . . it belongs to the family Capitonidae which is entirely absent on Lombok! The woodpeckers also, which are represented on the islands farther east by a single species only, are found on Bali in five different species. On the other hand I missed a whole number of species of birds which are characteristic for the islands visited previously . . ." (RENSCH 1930).

An unemotional statistical analysis of the faunal data tends to support RENSCH's assertions. The most striking feature of Wallace's Line is that it separates a zone with a rich animal life from a badly impoverished one. Borneo has about 420 species of breeding birds, Celebes only 220. Java has about 340 breeding species, Lombok only 120. It is even more true for freshwater fish: Borneo has 162 species of the carp family *Cyprinidae*, Celebes has none; Java has 55 species, Lombok has apparently only a single one. RAVEN (1935) shows that the Mammalian fauna is equally impoverished. The same is true for the Philippines, their fauna is badly depleted, as compared to that of Borneo and Palawan (DICKERSON *et al.*, 1928).

**The Geology of the Malay Archipelago:**—Why the islands Sumatra, Java, Borneo, and Palawan should have a rich animal life, whereas the Philippines, Celebes, and the Lesser Sunda Islands have a poor one, cannot be understood without a study of the geological conditions. The British geologist EARLE pointed out, as early as 1845, that geologically the Malay Archipelago consists

of three parts, a western one comprising the greater Sunda Islands and the adjoining parts of Asia, which was very stable during the Tertiary, an eastern one consisting of New Guinea and Australia, which was also stable, and an unstable island belt in between. The unstable area, comprising the Philippines, Celebes, the Moluccas, and the Lesser Sunda Islands, has a most complicated geological structure. Deep sea basins, up to the very end of the Mesozoic. The Tertiary was a period of very active orogenesis. Part of the Philippines and of northern Celebes seem to have been folded up first. There is some evidence for the existence of additional islands during Eocene and Oligocene, as, for example, in the Timor region, but the exact position, size and chronology of such islands is unknown. In early Miocene, or according to other authors in very

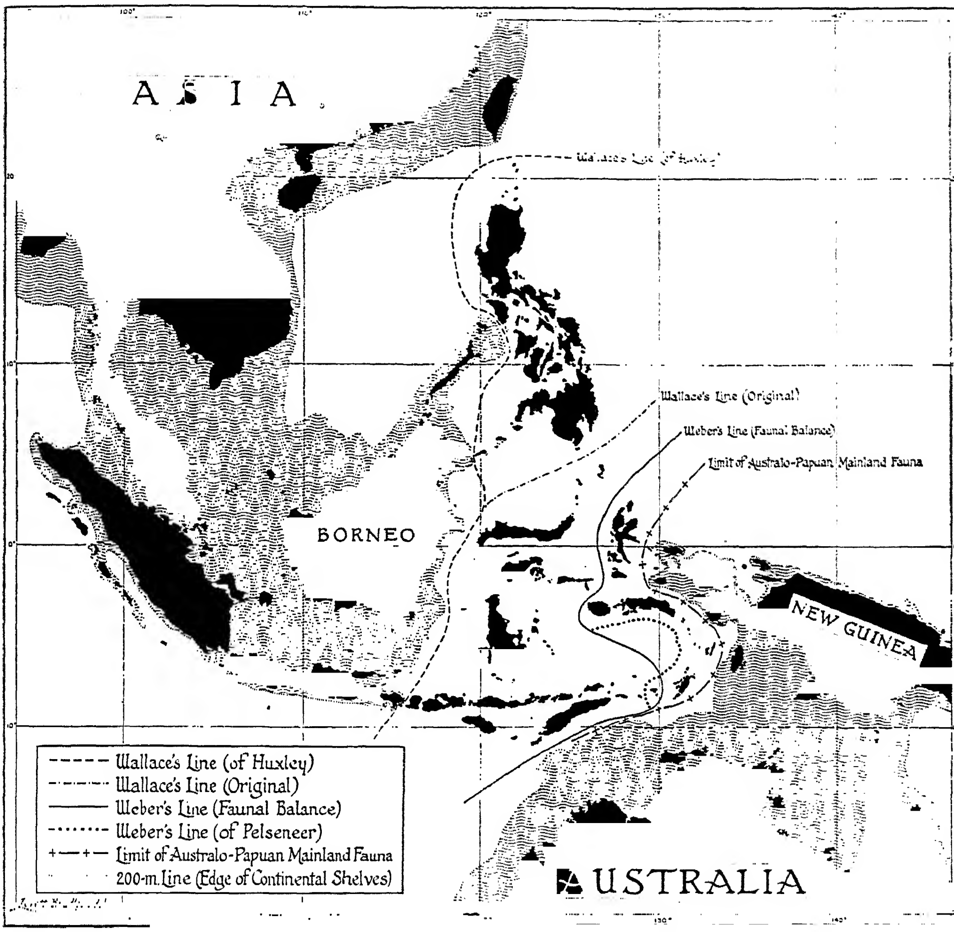


Figure 69. — Zoogeographic borderlines in the Malay Archipelago. The shaded areas are the continental shelves.

grabens, geosynclines and geanticlines are scrambled together in a bewildering manner. Geologists are still far from agreement in regard to the interpretation of these structures. So much, however, is clear — that this area is highly unstable and that it has seen many and violent changes in the recent past.

Originally, that is in late Mesozoic times, Celebes, the Moluccas, Misol, and western New Guinea, seem to have been situated on the same continental shelf. The fossil marine faunas of the mentioned regions, as well as tectonic features prove this close relationship. In fact, most geologists consider it as well established that Asia and Australia were in broad continental connection

late Oligocene, the crust of the earth seems to have buckled down in a gigantic manner along a line, which is roughly indicated by the west Sumatran Islands, Timor, Kei, Seran, and Halmahera. The very strong negative anomalies of the gravimetric measurements along this line are according to Vening Meinesz good evidence for the occurrence of such an event. The folding was so violent that it resulted in the widespread overthrusting of older strata over younger ones. The so-called outer Banda arc, consisting of the islands Sumba, Timor, Babber, Timorlaut, Kei, Seran, and Buru was formed along part of this fold. All of these islands are geologically very similar. Slightly later, but still in the Miocene, a second

fold was formed consisting of parts of Sumatra and Java, as well as of the so-called inner Banda arc (Bali, Lombok, Sumbawa, Flores, Alor, Wetar, Dammer, and Banda). Most of this fold remained, however, at first submerged under the ocean. In fact, some of the islands may not have emerged until well in the Pleistocene. Later in the Tertiary, particularly in the Pliocene and Pleistocene, extensive fault lines developed which led to the lifting of large blocks (marine terraces in Timor rose 1280 m.!) and the corresponding sinking of other blocks to form flat-bottomed deep sea basins. The geological data indicate that periods of violent tectonic activity have alternated with periods of relative quietness, and the frequency of earthquakes and the continuous volcanic activity in this region reveal that the orogenic movements have not yet completely died down. The writings of MOLENGRAAF (1922), UMBGROVE (1932, 1934), and KUENEN (1935) should be consulted for further details concerning the geology of this region. Three facts of zoogeographic significance seem to stand out among the geological data: (*1*) There is no evidence whatsoever for any continental connection between Borneo and Celebes. In fact, the distance between the two islands was, up to the Pleistocene, greater than it is today; (*2*) Java, Bali, Lombok, and the other islands of the inner Banda arc are situated on the same geanticline; and (*3*) there is no geological evidence for any cross connections between inner and outer Banda arcs, except possibly between Sumba and Flores.

The first of these three conclusions shows that Makassar Strait is an ancient ocean barrier and that at least this particular part of Wallace's Line is geologically well-founded. Geologists and zoogeographers are in full agreement on this point.

Tertiary geology supplies, however, no explanation for a faunal difference between Bali and Lombok, a difference which seems to be due to of 312 m., remained separated, even though it was fused temporarily with Sumbawa.

The geological background of Wallace's Line is thus as follows: In its central part, between Borneo and Celebes, it follows the edge of the continental Sunda shelf, in the south between Bali and Lombok (and the same is true in the north between Borneo-Palawan and the Philippines) it indicates the eastern edge of the Pleistocene Sundaland. The faunal break, which I have shown to exist along Wallace's Line, appears now in a new light. It is due to the fact that the line separates, on the whole, a continental from an insular fauna. This separation is clear cut in Makassar Strait, but it is rather obscured along the Sunda arc, where the geanticline of the inner Banda arc protrudes from Sundaland like a peninsula. Faunal breaks along this chain of islands occur not only on Lombok Strait, but also on all the other inter-island straits. A number of authors, among whom MERTENS (1930) is foremost, have contended, that some of the other straits, as that between Java and Bali, or the one between Sumbawa and Flores, are even more efficient distribution barriers than Lombok Strait. This assertion is in conflict with the above-given findings of Pleistocene geology and it becomes therefore necessary to examine the relative efficiency of these water barriers in more detail.

**The Efficiency of the Water Barriers Between the Lesser Sunda Islands:** — The faunal change between Borneo and Celebes is abrupt, but it is much more gradual along the west of Wallace's Line. The number of species of birds on this island chain is as follows: Sumatra about 440; Java, 340; Bali, 166; Lombok, 119; Sumbawa, 123; Flores, 143; and Timor, 137. In the freshwater fish family *Cyprinidae*, Sumatra has 115 species; Java, 55; and Lombok only a single one. Of butterflies Sumatra has 334 species; Java, 270

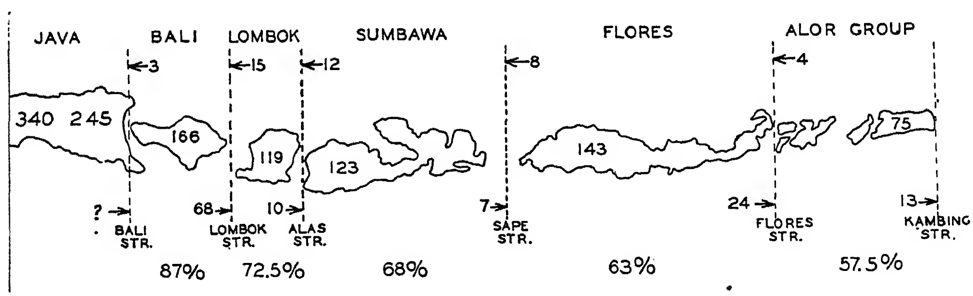


FIGURE 70. — INTER ISLAND STRAITS IN THE LESSER SUNDA ISLANDS AND THEIR EFFICIENCY AS DISTRIBUTIONAL BARRIERS FOR BIRDS (*explanation of the figures in the text*).

events of a more recent geological past. A considerable quantity of ocean water accumulated in the polar ice caps during the Pleistocene glaciations. It has been calculated that this resulted in a lowering of the sea level of tropical ocean by at least 70 m., but more probably by 150 m. This caused the drying up of all shallow seas and resulted in a considerable extension of land on Sunda and Sahul shelves (see Fig. 69). Sumatra, Java, and Borneo united with the Malay Peninsula in the formation of "Sundaland," an extension of the Asiatic mainland and Bali became attached to this continent. Lombok, however, which is separated from Bali by a strait of a depth

species. Of reptiles Sumatra has 193 species; Java, 136 species (RENSCH 1936). It is obvious from these figures that the animal life of Java is considerably impoverished as compared with that of Sumatra (or Borneo). The reasons for this are not entirely clear, but two factors seem to be most important. One is the heavy activity of the Javanese volcanoes, particularly during the Pleistocene, which covered a good part of the island with lava and ashes and may have exterminated a number of localized species. The second and more important reason is that Java is less humid and poorer in habitats than Sumatra, also more peripheral and thus less accessible to

colonists from the Asiatic mainland. The climatic deterioration, which is already indicated in western Java, accelerates rapidly in the eastern part of the island where in the lowlands true tropical rain forest seems to be largely replaced by monsoon forest. The result is that many of the most characteristic Java elements (including nearly all of the well-known endemics) are restricted to western Java. Of the 340 species of Java birds only 245 are found in the eastern half of the island and it is reasonable to believe that some 70 of these species drop out before the eastern tip of Java is reached, leaving only about 170 species for the eastern tip of the island. No natural history survey has ever been made of this section of Java. This is unfortunate because the fauna of a small area of easternmost Java, equivalent in size to Bali, must be compared with the Bali fauna, if one wants to test the significance of Bali Strait as a zoogeographic barrier. It would be entirely misleading to subtract the number of Bali species from the total number of Java species and state that the difference comprises the species that are unable to cross Bali Strait. This method was actually applied by MERTENS (1930) and BRONGERSMA (1936), who arrived thereby at the erroneous conclusion that Bali Strait was the most important barrier along the Sunda chain.

the number of breeding species known from each island (the second figure on Java gives the number of species on the eastern half of Java). The third row of figures, and this is the most important one of all, gives the number of western species that are halted by the various straits. The significance of Lombok Strait becomes at once apparent. It prevents the passage of 68 (41 per cent) of the 166 Bali species. No other strait approximates this figure. The last row of figures gives the percentage of western species on each of the islands.

The relative efficiency of Lombok, Alas, Sape, and Flores Straits can be expressed by calculating what percentage of the species occurring on either side are stopped by the straits. Lombok Strait, for example, is a barrier for 83 (= 68 + 15) species of a total of 285 (166 + 119), that is, 29.1 per cent. The percentages for the other straits and for a number of other animal groups are given in Table 2.

The figures of Table 2 have, of course, only a relative value since the species totals include many species twice, once east and once west of the straits. Still they are valid as indicators of the relative efficiency of these straits and of their rank. Many of the smaller islands (Penida, Komodo, Sangeang, Rintja, etc.) are insufficiently

TABLE 2
*Relative efficiency of straits in Lesser Sunda Islands*

| | BIRDS (ORIG.) | REPTILES, AMPHIBIA, BUTTERFLIES AND LAND MOLLUSKS (RENSCH) | RANK (FOR BIRDS) |
|---|---|---|---|
| Lombok Strait (Bali-Lombok) | 83 of 285 = 29 per cent [1] | 84 of 377 = 22 per cent | 1 |
| Alas Strait (Lombok-Sumbawa) | 22 of 242 = 9 per cent | 34 of 367 = 9 per cent | 3 |
| Sape Strait (Sumbawa-Flores) | 15 of 266 = 5.5 per cent | 52 of 364 = 15 per cent | 4 |
| Flores Strait (Flores-Alor) | 28 of 218 = 13 per cent | | 2 |

A faunal change between the western and the eastern end occurs probably not only on Java, but on all elongated islands of the Sunda chain such as Sumbawa, Flores, and Timor. This fact invalidates to some extent the figures on the subsequent calculations, but it is fortunately of minor importance in respect to the small and rather round islands of Bali and Lombok.

This is by no means the only difficulty that is encountered in the attempt to determine the relative efficiency of the various straits in the Sunda chain. It happens that there is a gradual but steady change of climate and plant cover from west to east. Each more easterly island is somewhat more arid than its western neighbor and one after the other of the humidity-loving species drops out because the habitat becomes unsuitable and not necessarily because it can not cross the water barrier separating it from the next island.

The effect of six inter-island straits on the distribution of birds is illustrated in Fig. 70. The top line of figures records the number of eastern species that find the western limit of their ranges on the inter-island straits. Lombok Strait shows the highest figure with 15 species, but, on the whole, the difference between the various straits is rather slight. This is not surprising, since all the eastern species have the ability to jump water barriers and it is probable that the ecological factors on the islands have as much or more to do with the limits of the ranges than age or width of the straits between them. The second row of figures gives explored and have therefore been omitted from the tabulation. Solor, Adonara, Pantar, and Alor have been united as Alor group. In the tabulation of the borders of western species only the easternmost occurrence has been used. This explains a seeming discrepancy of the figures. Flores Strait, for example, stops only 24 of the 143 species on Flores. One would expect the Alor group to have 119 species (143 less 24), but it actually has only 75. The "missing" 44 (119 less 75) species are, however, found on Wetar, Timor, or other more easterly islands, which proves that Flores Strait is not the eastern limit of their range.

The data presented in Fig. 70 and in Table 2 can be summarized as follows: Each of the straits in the Lesser Sunda Islands is a zoogeographic barrier. Lombok Strait, however, is more effective than any of the others. This is apparently due to the fact that this strait persisted throughout the Pleistocene, whereas Bali Strait and Alas Strait dried up at the height of the Pleistocene glaciation. RENSCH's data (Table 2) indicate that reptiles, amphibia, butterflies, and land mollusks show similar conditions as birds and it is possible that a more thorough exploration of Bali, Flores, and Alor would make the two sets of data even more similar. MERTENS (1930), for example, who denies that Lombok Strait is a more important barrier than Bali or Sape Straits, bases this claim on a study of the very insufficiently known herpetofauna of Bali. DE BEAUFORT

[1] This figure indicates what percentage of the sum of the species of the two islands on either side of the strait have not crossed the strait.

(1926) and other students of freshwater fish are also handicapped in a discussion of this subject, since with few exceptions there are no true freshwater fish east of Lombok Strait. Even Bali has a badly depleted fish fauna. That this island is so poor in freshwater fish is not really surprising, since it is a volcanic island and has not a single large and only one medium-sized stream. It would be dangerous to base too many conclusions on the distributional data derived from a single group which is so exacting in its ecological requirements as are freshwater fish.

Freshwater fish are useful as negative zoogeographic indicators. The fact that primary freshwater fish (see MYERS, 1938, for a definition of this term) are absent from Seran and Kei indicates, for example, that these islands have had no continental connection with New Guinea. The presence of four species of freshwater fish in the lesser Sunda Islands — *Rasbora elberti* on Lombok and Sumbawa; *Clarias batrachus* on Bali, Lombok, and Sumbawa; *Aplocheilus javanicus* on Lombok; and *A. celebensis* on Timor — does not necessarily prove continental connections for these, but it casts doubt on the means of dispersal of these species. The slight, or absent, differentiation of these species demands that these islands had a recent continental connection. However, if such had existed one would expect a much richer fish fauna. The transport of fish by water spouts is well substantiated and it is also possible that Lombok Strait had occasionally a surface sheet of freshwater while it was the outlet for the large streams of Pleistocene Sundaland. It would be dangerous to go too far in such speculations of possible chance dispersal but it is even more dangerous to base sweeping zoogeographic conclusions on the presence of a few species of so-called freshwater fish.

**The Eastern Counterpart of Wallace's Line:** — It is obvious that there must be a line at the eastern edge of the island belt which corresponds to Wallace's Line in the west. Such a line would separate the zone of a more or less pure Australo-Papuan mainland fauna from the islands to the west with an impoverished Papuan fauna and an Indo-Malayan admixture. This line has been vaguely referred to by LYDEKKER and other nineteenth century writers, but I believe DE BEAUFORT (1913) was the first to point out its true significance. It is not difficult to trace since it follows, except for a short stretch in the north, the 100 m. depth line, that is, the edge of that part of the Sahul shelf that was dry land at the height of the Pleistocene glaciation (Fig. 69). It passes between the Aru Islands, which have a pure Papuan fauna, and the Kei Islands with an impoverished fauna with Oriental elements. Of birds, for example, 166 species are known from the Aru Islands, including birds of paradise and many other typical Papuan types, while only 84 species are known from the Kei Islands, including some western elements. The line then passes between the mainland of New Guinea and Seran Island. There are 115 species of birds (about 30 per cent western) known from Seran as against more than 300 species from the Vogelkop, the neighboring part of New Guinea. The line that separates the Papuan mainland fauna from the island fauna swings from Seran north and passes through the Gilolo passage separating the western Papuan Islands (Waigeu, Batanta, Salwati, and Misol) from the Northern Moluccas. In this section the line does not follow entirely the 100 m. contour, which would exclude Koffiau, Gebe, Batanta, and Waigeu. However, all these islands are so purely Papuan and form such a well-defined faunistic unit that it seems justified to be slightly inconsistent. It might be worth while to emphasize that the line, as just drawn, gives a better defined delimitation of the "Papuan mainland" and "Papuan island" fauna than does Wallace's Line in the west for the Indo-Malayan fauna. Its validity is particularly apparent for all groups with a limited dispersal faculty, for example freshwater fish. DE BEAUFORT's map (1926, p. 103) of the range of the subfamily *Melanotaeniinae* illustrates it quite graphically. This Australian group extends westward as far as the Aru Islands and Waigeu, but is absent from the Kei Islands and from the Northern and Southern Moluccas.

The significance of this eastern line has been emphasized by a number of authors. It indicates, like Wallace's Line, a major faunal break; it separates, like its western counterpart, a continental from an island zone, as well as a zone with a more or less undiluted Papuan fauna from a mixed Papuan-Oriental fauna, a contrast which is least apparent in the north. It is for all these reasons that this line must be considered a major zoogeographic boundary.

**Should an Intermediate Zoogeographic Region Be Recognized?** — A gradual transition between the Oriental and the Australian faunas takes place in the island belt between Wallace's Line and its eastern counterpart. This was realized quite clearly by SALOMON MÜLLER (1846), the earliest zoogeographer of the Malay Archipelago. He lists correctly "Celebes, Flores, Timor, Gilolo and perhaps Mindanao" as islands on which a mixture of Indian and Australian elements is found. WALLACE also, in his later publications, admitted the intermediate position of this region and stated of Celebes that it "hardly belongs to either [Oriental or Australian] region." PELSENEER (1904:1007) lists a whole group of workers who recognized the transitional character of this region.

There are other factors, in addition to the lack of continental connection, which contribute toward the poverty of the fauna of this island belt. SALOMON MÜLLER (1846) very ably pointed out some of the reasons, such as the small size of most of the islands, their low elevation and their aridity. There is a more or less arid corridor extending from the Philippines and Celebes to Buru and to the Sunda Islands from eastern Java to Timorlaut. This zone has acted as a barrier to many humidity-loving forms and has prevented their passage from Sundaland to the Papuan Region or vice versa. Additional reasons for the faunal poverty of this zone are the young geological age of many of the islands, which limits the number of chance colonizations, and the heavy volcanic activity over part of the region. There are three lines of volcanoes in this transition zone, one extending from Sumatra through Java to the inner Banda arc, a second one following the western edge of the northern Moluccas, and a third one reaching from north Celebes through the Sanghir Islands to the Philippines. The volcanic activity is thus strictly localized, but where it occurs it may be a very serious factor indeed. As mentioned, it seems to be one of the reasons why Java's animal life is so much poorer than that of Borneo or Sumatra (RENSCH, 1936).

There are not only 59 young volcanoes of more than 2000 m. altitude on Java, but also many extinct late Tertiary ones. This factor is even more evident on Lombok where heavy Pleistocene eruptions of Mount Rindjani seem to have destroyed much of the mountain fauna. The same is true for the volcano on Ternate Island (Stresemann, 1939:381).

All the mentioned factors combine to give the fauna of the transition zone a peculiar character. This has impressed some of the authors to such an extent that they have proposed to give formal recognition to this fauna and elevate the island belt to the rank of a separate zoogeographic region or subregion.

Dickerson *et al.* (1928), who coined the term *Wallacea* for this region, and Rensch (1936), who simply calls it *Zwischengebiet* (region of intermediacy), are the two most recent champions of such an arrangement. This region would include four different groups of islands, (1) the Lesser Sunda Islands from Lombok eastward; (2) the Moluccas and other outliers of the Papuan Region (Tenimber, Kei); (3) the Celebes group (with Sula and Talaut); and (4) the Philippines. Two reasons are usually quoted in favor of recognizing such a transition region. One is, that many endemic species and genera are confined to it. The other reason is, that all of the islands, which are included in this transition zone, are populated by a mixture of Indo-Malayan and Australo-Papuan elements. As against these points which would favor the recognition of a transition region there are some very strong objections. Pelseneer (1904) has stated them clearly. He points out that it is only natural that

> a zoogeographic border is not a line without width and that by necessity there is a mixture of faunal elements along the border of two zoogeographic regions, caused by a reciprocal penetration.
>
> But if one would admit for this reason a special "transition region" or a "region of intermediacy," one would obviously double the difficulties of delimitation. For now it would be necessary to trace both of the border lines which separate the transition region from either of the two adjoining zoogeographic regions.

These difficulties of delimitation are fully confirmed by the two most recently proposed transition regions. Dickerson *et al.* (1928:297) define theirs as follows: "Wallacea is outlined sharply by Wallace's Line (as modified) on the west and Weber's Line upon the east." It thus includes the Philippines, but it excludes the Moluccas, Timorlaut, and Kei Islands. Rensch (1936:265), however, includes in his *Zwischengebiet* "Celebes, the Lesser Sunda Islands, Timorlaut (perhaps also Kei) and the Moluccas (at least the southern Moluccas)." He definitely excludes the Philippines. Celebes and the Lesser Sunda Islands are, thus, the only two districts which the two transition regions have in common.

The "degree of intermediacy" of the various sections of the transition region is very uneven. It seems, for example, that the percentage of Australo-Papuan species in the Philippines (which are included in Wallacea by Dickerson and Merrill) is smaller than the percentage of Oriental species in New Guinea or Australia. Still, nobody would want to suggest including Australo-Papua in the transition zone.

Stresemann (1939:403) adds another weighty objection. He points out that the transition zone comprises four separate districts which have much less in common with one another than each one has with some outside region: The Moluccas are faunistically closest to New Guinea, and Celebes to the Philippines, but the Philippines are closer to Malaysia than to Celebes. The Lesser Sunda Islands, finally, have a close faunal relationship with Java and Australo-Papua, but only a very slight and recent one with Celebes. To unite four such heterogeneous districts in a single "region" violates all principles of regional zoogeography. After all, if a zoogeographic region means anything, it means the home of a more or less homogeneous characteristic fauna. "Wallacea," however, is the home of four different faunas. It is self-evident that the formal recognition of a zoogeographic region of such heterogeneity is neither practical nor scientifically defensible. The term transition zone is justified only if applied informally as a descriptive attribute.

**Weber's Line:** — It is apparent from the preceding discussion that neither Wallace's Line nor the formal acceptance of a transition zone are satisfactory attempts of delimiting the Oriental against the Australian Region. This leaves, to my mind, only one other alternative solution, namely, the recognition of a line east of Wallace's Line. Before attempting to draft the best possible course of such a line, a few words must be said about the validity of any zoogeographic borderline.

A zoogeographic region is usually defined as a geographic subdivision of the earth that is the home of a peculiar fauna. Such a region is characterized by the presence of many endemic genera and families and by the absence of the characteristic genera and families of other zoogeographic regions. Its border should be drawn along the line where this specific fauna is replaced by a different fauna. This procedure is logical and presents no difficulties in all the cases where an efficient barrier separates the two regions, such as is formed by the South Atlantic between Africa and South America. However, an intermingling of the two faunas takes place in a border zone whenever two such regions come into direct contact. This is exactly what has happened in the island belt between Asia and Australia. Both the Indo-Malayan and the Australo-Papuan mainland faunas have spilled over into the intermediate island belt and it might seem impossible to delimit in such a mixed region one fauna from the other one. However, as Pelseneer (1904) says correctly, "it is evident that there must be a line . . . within the region of mixture, on one side of which the faunal elements of one region prevail and on the other side those of the second region. This line can serve usefully to mark the borderline between the two biogeographic regions."

On the basis of these considerations Pelseneer established a borderline between the Oriental and the Australian Regions, which he called "Weber's Line." Pelseneer drew the course of this line on the basis of non-zoological data, that is, primarily on the soundings and other oceanographic results of the Siboga Expedition, many of which are no longer valid today. However, Weber's Line actually separates the islands with a more than 50 per cent Indo-Malayan fauna from the islands with a more than 50 per cent Papuan fauna, as is evident from Rensch's (1936) careful data and from all the other zoogeographic work of the region. With insignificant modification the line suggested by Pelseneer is still acceptable as the best possible borderline between the Oriental and the Australo-Papuan Regions.

The course of Weber's Line (Fig. 69) is as fol-

lows: In the north it begins between Talaut and Celebes in the west and the northern Moluccas in the east. In this section the line is extremely well defined, since the fauna of the northern Moluccas consists of about 80–90 per cent and that of Celebes of about 20–40 per cent Papuan elements. The line continues from here between the Sula Islands in the west and Obi in the east and then swings around Buru. The fauna of the Sula Islands is insufficiently known, but it is close to that of Celebes except much poorer and with a stronger Moluccan element. Still the Papuan component is probably less than 40 per cent, while it is about 63 per cent on Buru and even higher on Obi. It is difficult to trace Weber's Line from Buru on. PELSENEER attempted to follow the contour of the ocean bottom and this caused him to run the line between Banda ("Indo-malayan") and Seran ("Papuan") and between Sermatta ("Indo-malayan") and Babber ("Papuan"). The much more detailed information on the fauna of these islands, which is now available, indicates that a different course might be preferable. The young volcanic Banda Islands have a fauna which almost completely lacks endemic elements, and which is very close to that of Ambon, Seran, Seranlaut, etc. There is no doubt that the Banda Islands must be included in the southern Moluccas. Babber, on the other hand, has a fauna which is closer to that of Dammer and Sermatta, than to that of Timorlaut. It is, therefore, preferable to place the line between Babber and Timorlaut. RENSCH (1926:206) has already pointed out the impossibility of separating Babber from the closely related Sermatta and Dammer. The fauna of Timorlaut is about 62.5 per cent Australo-Papuan. South West Islands, from Roma and Kisar to Dammer and Babber are a faunistic unit, but the progressive decrease of Indo-Malayan elements which started on Java and Bali continues on these islands. It is possible that a future analysis may show that the eastern element on Babber and Dammer is already slightly more than 50 per cent of the total fauna of these islands. Even then I would be inclined to retain them in the Oriental Region rather than to draw a line through the middle of the South West Islands.

One glance at the map shows that Weber's Line is situated much closer to the Australo-Papuan than to the Asiatic shelf. The reason for this is twofold, faunal pressure and accessibility. The faunal pressure of the Indo-Malayan fauna is greater than that of the Papuan fauna because it is much richer in species and families. The sphere of influence of this rich fauna will, therefore, extend farther into the island belt than that of the poorer Papuan fauna. The second reason is that the chain of the Lesser Sunda Islands, forming practically a peninsula of Sundaland, was infinitely more easily accessible to colonists from the west than to those from the east, which had to jump the wide gap either from Australia to Timor or from New Guinea (and Aru) to the islands of Banda Sea. The preponderance of Oriental species in the Lesser Sunda Islands would be even more pronounced if ecological factors (aridity) had not favored colonization by Australian elements. These various factors explain the present course of the line of faunal balance, Weber's Line. WALLACE's argument that Celebes should be included in the Australian Region because it had so few Oriental species as compared to Borneo, is beside the point. Every true island has, of course, a much impoverished fauna, but its zoogeographic position is determined by an analysis of its existing fauna and not by the elements it lacks. With an 80 per cent Oriental fauna Celebes can not be included in the Australian Region!

Weber's Line has found curiously few adherents among zoogeographers; BODEN KLOSS (1929) is one of the exceptions. There is nothing spectacular about this line and by crossing it one encounters a smaller faunal change than is found between Borneo and Celebes, or between New Guinea and Seran, or in general between the "mainland" and the "island" faunas (Fig. 69). The difference between the faunas of Sula and Buru and of Babber and Timorlaut is, indeed, rather small. Weber's Line is not acceptable to those who look for a strikingly conspicuous borderline between the Oriental and Australian Regions (RENSCH, 1926:265).

Other objections have been raised against Weber's Line. Some authors, for example, have objected to Weber's Line because it separates islands which lie on the same submarine ridges. Thus it cuts between Babber and Timorlaut, between Dammer and Banda, and between Sula and Obi, each of these three pairs of islands lying on the same submarine ridge. It seems to me that this argument is another instance of confusing zoogeographic and geological interpretations, exactly as in the case of continental versus oceanic islands (MAYR, 1941). The geology of an island, and particularly of an oceanic island, is of no concern whatsoever, when we are attempting to classify its fauna. If the fauna of Seran and Kei is prevailingly Papuan, I shall classify these islands with the Papuan region. The fact that Timor and Sumba with a prevailingly Indo-Malayan fauna lie on the same tectonic arc has absolutely no bearing on this decision. In fact there is no evidence that any of these arcs were ever raised to the extent that they were exposed for their full length, and it is obvious that the undersea geology can have no influence over the distribution of forms that are dispersed across the water.

DE BEAUFORT (1926:184) also rejects Weber's Line for a purely geological reason, because "the Moluccas are not the remains of a former greater land mass." This argument is entirely irrelevant, not only since PELSENEER nowhere makes such a claim, but also because the former geological history has a bearing on zoogeographic classification only to the extent to which it influences present day distribution.

I know of only a single valid argument against the adoption of Weber's Line as the boundary between the Australian and the Oriental Regions. It is the objection against dividing arbitrarily any continuous series of values at the halfway point between the extremes. In the case of Weber's Line the situation is aggravated by the fact that the 50-50 balance between the Indo-Malayan and the Australian elements is not always the same in the various taxonomic groups. The bird fauna of Wetar Island, for example, is more than 50 per cent Australo-Papuan, while in other groups the Oriental element seems to prevail. On Celebes about 67 per cent of the birds are of western origin, while among mammals, butterflies, reptiles, amphibians, and land snails it is more than 80 per cent. On the whole it seems as if among reptiles and butterflies the western element pushes farther eastward than among birds and

snails. However, taking the fauna as a whole, Weber's Line seems to separate rather neatly the islands with a prevailingly Oriental fauna in the west from the islands with a prevailingly Australo-Papuan fauna in the east. As stated above, the easternmost of the South West Islands (Dammer and Babber) possibly have slightly more than 50 per cent Australo-Papuan elements, but it is inadvisable to separate them from the larger group of islands of which they are an integral part. Lines of 50:50 balance face even more difficulties on continents than in archipelagos. The line in North America on which the Palearctic and the Nearctic elements balance, would be entirely unsuitable as a zoogeographic boundary. A 50:50 line is, thus, admittedly a more or less arbitrary boundary and may have to be modified in special cases. But it is no more arbitrary than to accept March 21st as the first day of spring (regardless of the weather!), or the 21st birthday as the day on which an adolescent reaches seniority. Such rigid divisions are of practical usefulness not only in human affairs, but frequently also in scientific matters. Different faunal regions are generally indicated on zoogeographic maps by different colors. It is obvious that the 50:50 line is the most convenient place where to replace one color by another. It is in this sense that Weber's Line (as modified above) may be accepted as the boundary between the region with a prevailingly Oriental and the region with a prevailingly Australo-Papuan fauna.

**Unsolved Problems of Indo-Australian Zoogeography:** — The conclusions at which I arrived in the present analysis are not final. Many of the islands are insufficiently explored and it is certain that future exploration will add a good deal to our knowledge. A further refinement in the zoogeographic methods is also expected to yield increased results. Salomon Müller, P. L. Sclater, A. R. Wallace, and other early representatives of the classical school of zoogeography selected arbitrarily a number of indicator species and based the outlines of the zoogeographic regions and subregions on the distribution of these species. The preferred technique of the present paper is to calculate in percent the proportion of faunal element in the total number of species of certain localities. All the percentages in Fig. 70 and Table 2 are derived by this method.

In the matter of faunal composition an even superior method might be to determine the faunal relationship of the dominant species of each habitat. It seems, for example, to judge by Rensch's description (see above) that the differences between the dominant species of birds of Bali and Lombok is even more striking than is apparent from a statistical analysis of the total faunas. Such a comparison of the dominant types of local faunas must be based on accurate census data gathered in the field and such data are not yet available. To gather them would be a worth while task of future explorers of the Malay archipelago.

The combination of ecological and zoogeographic methods promises to yield data of considerable interest. It seems, for example, that the faunal composition of each habitat is different. Of the eleven species of birds that are restricted to the mountain forest of Timor (above 4000 feet) only a single one is Papuan, the other ten are Indo-Malayan. The ratio is even, if not reversed, among the birds of the tree savanna of Timor. Lack of exact ecological data prevents a more accurate analysis at the present time. Steenis and other botanists have shown that a similar difference of floristic composition exists between different plant associations. Here is a practically untouched field for future investigators.

The delimitation of biogeographic regions depends to a considerable extent on the dispersal faculties and on the nature of the speciation processes of the organisms of which the distribution is studied. It has become evident in recent years that there is much difference between phytogeographic and zoogeographic classifications. The major floristic regions coincide fairly well with the major climatic regions. The major zoogeographic regions, on the other hand, indicate primarily the extent of formerly (or currently) isolated land areas. The biogeographic classification of New Guinea is a good illustration for this. New Guinea is, for the phytogeographer, a part of the Malayan region, but faunistically it is at least as close or even closer to Australia. A comparison of phytogeographic and zoogeographic maps indicates that it is impractical at the present time to construct biogeographic maps, that is, maps that intend to illustrate simultaneously the distribution of plants and of animals.

This is equally true, although to a lesser extent, for animal groups with different dispersal faculties. I have already mentioned above the differences between birds and reptiles in regard to the faunal composition of some of the islands. Much more accurate data are needed. It is possible that some of the invertebrates show a distributional pattern that is much more similar to that of plants than to that of mammals or birds. Progress in this field depends largely on a more thorough faunistic exploration of the Indo-Australian Region.

**Summary:** — (*1*) Wallace's Line is not the boundary between the Indo-Malayan and the Australian Regions, but rather it indicates the edge of the area (Sunda shelf) that was dry at the height of the Pleistocene glaciations.

(*2*) The equivalent line along the edge of the Sahul Shelf separates New Guinea and the Aru Islands from the Moluccas and Kei Islands.

(*3*) Weber's Line separates the islands in the west on which the Indo-Malayan element is predominant from the islands in the east on which the Australo-Papuan element has a numerical superiority.

**Postscript:** — The results of an important symposium on Wallace's Line and on the zoogeography of the Indo-Australian archipelago (Scrivenor, *et al.*, 1943) have been published after the completion of the present work. These papers contain nothing that would require a major modification of the conclusions at which I have arrived above. However, they contribute a considerable amount of interesting factual data and raise a number of questions which I have not treated. Corbet (*op. cit.*) shows that Weber's Line, at least in its northern part between Celebes and the northern Moluccas, constitutes a more pronounced faunal division in several families and genera of butterflies than Wallace's Line in its most effective section (between Borneo and Celebes). Malcolm Smith (*op. cit.*) comes to the conclusion, on the basis of the distribution of vertebrates, that Weber's Line is preferable to Wallace's Line, if a single borderline between the Oriental and the Australian Regions is to be found. The botanical contributors emphasize the dis-

crepancy between the classification of biogeographic regions of the zoologists and of the botanists. This disagreement is much less striking in regard to the minor divisions.

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# CLIMATE AND SOIL IN THE NETHERLANDS INDIES

*by*

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Points on which the Netherlands Indies differ intrinsically from both Europe and the United States of America are climate and soil. To say that the Netherlands Indies are located in the tropics, is to put the case too vaguely. This expression — the tropics — covers the whole broad belt between the tropics of Cancer and Capricorn, or between 23° N. lat. and 23° S. lat. But within this vast belt itself great differences of climate are found and the strip between 10° N lat. and 10° S. lat., within which the Indies lie, is quite distinct from the regions flanking it on either side and may be appropriately called the tropical zone in a special sense. The fact that the Indies do not form part of a continent, but are a group of islands, accentuates this tropical character very greatly, particularly as regards rainfall.

The first thing to realize is that in the Netherlands Indies the seasons do not vary in the same way as they do in Europe. For instance, in those regions there is no summer, when days are long and nights short, to be followed by winter in which the converse is true. Apart from a small variation of about twenty minutes at the extreme North and extreme South of the archipelago, the days and nights all over the Indies are each about twelve hours long all the year round. As in this region of the earth the sun in its daily course ascends and descends almost perpendicularly to the horizon, the periods of dawn and dusk are always short.

As every day at noon the sun stands high in the heavens and shines for the same length of time, or very nearly, it is clear that the daily variations of temperature will be practically the same at every point in the archipelago. Particularly hot or particularly cold days differ but a few degrees from the average. But curiously enough it seems to be the very slightness of this variation which makes human beings so sensitive to such changes of temperature as do occur. As a matter of fact, in the Netherlands Indies the thermometer very seldom registers what one thinks of as tropical heat, but then we must reflect that temperature is but one of several factors in respect to atmospheric conditions as affecting the human senses. The maximum temperature at sea-level hardly ever exceeds 33° Centigrade there, while in Europe or the U.S.A. it often reaches 38° or 40° C., and in Arabia and Southern Persia even 45° or 50° C. On the other hand the temperature at night shows a smaller drop inside the zone referred to than outside it, and seldom falls below

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23° or perhaps 21° C. The daily margin being so slight and the temperature moving practically between the same limits every day, it is small wonder that even at the depth of only one metre the soil shows no variation in temperature at all, remaining constant at 25° or 26° C. (at sea level). In Europe a constant soil-temperature could only be expected at about ten times this depth.

There are large stretches of low-lying, flat country in the Netherlands Indies, but the archipelago also includes highlands where considerable altitudes are reached. The higher one goes, the cooler it gets. Every 160 metres makes a difference of 1° C.; at a height of 1600 metres, or almost 5000 feet, the average temperature is, therefore, 15° to 16° C., rising to perhaps 21° or 22° C. in the course of the day and dropping at night to 10° or 11° C. — a delightful climate, this, as regards temperature; one in which we humans can enjoy life and feel perfectly comfortable. At 2400 metres the average temperature is about 10° C. This same figure is well known as the mean annual temperature of many places in Western Europe, but it would be a mistake to conclude from this fact that therefore a community of Europeans would find equally appropriate conditions for living in both regions. For though the average temperature is the same in both, there is one great difference which must not be forgotten. In Western Europe the average winter temperature is 0° C. and the average summer temperature 20° C.; in the tropics the temperature in these seasons varies hardly 1° instead of 20° C., which, for the people who live there, means what Ernst Haeckel, the great German biologist of the nineteenth century, called "the everlasting sameness", and which certainly does not produce a stimulating effect on the human organism — not to mention such extremely important factors as the influence of a practically constant temperature on the vegetation itself and on the activities of micro-organisms in the soil. The only variation the weather undergoes is due to changes of moisture, cloudiness or rainfall. And these changes may be traced to one of two causes, one local in origin, the other general.

The local cause usually arises on or near the slopes of high mountains or mountain ranges in the various islands. During the morning hours the sun shines on these and on the coastal areas and warms them more than it does the adjacent sea. The air above the land also gets warmer than that which is above the water; it becomes lighter, rises and is replaced by air coming in from the sea. This movement causes a current of very damp air flowing from the sea to the mountain slopes; as it rises, the air cools, the vapour condenses to form heavy cumulous clouds and heavy rain, often accompanied by a sharp thunderstorm, until during the afternoon equilibrium is established once more. Towards sundown and during the night, the land gets cooler than the sea. Consequently the cooler air from the mountain descends to the sea and thereby becomes slightly warmer again, while remaining clear under the clear, starlit sky. Next day the same series of changes recurs — clear morning, then clouds, rain, clear weather once more; unless, indeed, monsoon winds produce a change in the usual sequence.

These monsoon winds are not local in origin and constitute the general cause referred to above. They arise in the following manner: In June the sun is far to the North. At this season it is hot in Southern Asia and comparatively cold in Australia. Over Asia cyclonic conditions prevail, in other words, in S.E. Asia the prevailing wind is from the S.W.; this changes its course and becomes South Easterly in so far as it comes from South of the equator in the Netherlands Indies. Over Australia an anti-cyclonic condition prevails, causing a South East wind across Northern Australia, which arrives in the Netherlands Indies as a dry wind from S.E. to E. This dry East monsoon blows from May to September, or even a little longer, especially in the Southern portion of the archipelago. The further North or West it gets, the less strongly it is felt.

In December the sun stands far to the South, above the central part of Australia. This means that the cyclone is now there, and that consequently the prevailing wind blowing across Northern Australia and South of the archipelago is from South West to West. At this season it is cold in Asia, which fact causes a North East wind that, on crossing the equator, turns into a North West wind. This wind is noted everywhere throughout the Indies as a wet monsoon, especially when it blows conjointly with the South Westerly Ocean breeze caused by Australia. Wherever it meets highland country or mountains on its course, it causes heavy rains, especially on the West coast of Sumatra, in Java, Borneo and Celebes.

Rain or dry weather in the plains is a matter depending chiefly on the dry monsoon; but on the sides of the mountains the rainfall is only increased or decreased by this wind. Hence there are regions where it rains practically every day of the year, because the dry monsoon does not penetrate there. The portion of Sumatra near the equator, almost the whole of Borneo and large portions of New Guinea are cases in point; on the other hand we find regions, such as the Northern coastal part of East Java and the Small Sunda Islands, where the East monsoon is very dry and lasts very long. Between these two extremes are all sorts of intermediate conditions. But there is hardly a spot in the whole of the Netherlands Indies where it does not rain hard for at least three or four months of the year.

The heavy rainfall of between 1 to 7 metres per year, which is particularly characteristic of these tropical areas, strongly affects the soil and consequently the vegetation. For the abundance of rain-water not only wets the soil, but most distinctly leaches it at the same time. All substances that are soluble in water, however slight the solubility may be, are dissolved in the long run and finally carried away into the depths of the earth to springs, and thence to rivers and to the sea. This process also takes place in the very damp portions of the temperate zones, but there it works much more slowly, firstly, because the rainfall is less, and secondly because the temperature is lower — a circumstance which greatly decreases solubility.

A very significant point is the fact that among these soluble substances are those which serve to feed the vegetation. Hence we may say that in all tropical regions the soil is constantly being impoverished, is everywhere tending to a final condition which would make all vegetable growth impossible, because it would mean that plant food was entirely lacking. Fortunately there are a number of factors which greatly, in some cases very greatly, retard the process towards this fatal end, or even very largely prevent its accom-

plishment. Human welfare demands that we should know exactly what these factors are and, if possible, learn to promote their action.

It is obvious that leaching decreases with the rainfall. Hence in areas where the dry East monsoon is felt, the soil is generally comparatively fertile, and what is more, retains its fertility comparatively long. This rule applies all over the globe. All old civilizations which have been able to hold their own for many centuries have had little rain. Cases in point are Mexico, Peru, Carthage, Egypt, Palestine, Mesopotamia, India, China. The most highly developed cultures that have appeared in the Netherlands Indies flourished in Middle Java, East Java, and the islands of Bali and Lombok, that is, in areas where the total yearly rainfall was not more than two metres and the East monsoon was strongly felt.

The lower the temperature, the less intensive the leaching. This is why often the leaching of the soil on the sides of the mountains and on the plateaux is less advanced than at the foot of the mountains and in the lowlands. This comparison only holds good when the areas compared have an equal and similar rainfall. Examples drawn from the Netherlands Indies are seldom really telling, because the rains that fall there on mountain slopes at high altitudes are often very heavy. In such regions the greater quantity of rain-water compensates the lower temperature.

As eruptive rocks disintegrate and decompose, soil is produced. This soil always contains clay and this clay possesses the faculty of absorbing plant-food from the water circulating in the soil, and discharges it very slowly. This absorption counteracts the leaching process and retards it. Humus performs a more or less similar function. Soil rich in clay and humus impoverishes slowly; quartz-sandy soil impoverishes quickly. Luckily the rocks in Java do not contain much quartz and hence there is little quartz-sand in the soil there, but in many parts of Sumatra, Borneo, Celebes and New Guinea the soil is rich in that sterile mineral, quartz This same is true of the Congo and many parts of Europe and America.

In the tropics humus is always at a disadvantage, for the higher the temperature, the greater the rate at which the humus is decomposed and mineralized, whenever moisture and air are plentiful. For this reason the soil in low-lying areas contains relatively little humus, particularly where forests have been absent for a long period of time. The higher we go, the cooler it is, the richer the soil is in humus. Hence it is on the mountain slopes that the flourishing tea and cinchona plantations are to be found; the best are on newly cleared forest-land.

In the tropics rain almost always comes down in the form of a sudden downpour such as in Europe would certainly be termed a cloud-burst. This type of rain-storm produces another effect on the soil besides the chemical leaching described above, namely, mechanical surface washing, or erosion. Whenever the ground slopes even slightly, the rain-water, streaming down swiftly over its surface, carries away soil, in particular the valuable top-soil containing humus. After a number of such heavy showers have fallen on an open piece of arable land all the top-soil is washed away into the brooks and rivers and transported to the lowlands and the sea, and nothing remains but the naked sub-soil. When this has occurred on an estate, we may say that it has lost most of the capital value represented by the soil, especially where the sub-soil is old, leached out, senile. In such cases it is very difficult to induce new vegetation to grow on this very poor soil. If the sub-soil is not yet worn out but still juvenile, the task will be easier and the results more promising; but even then it can only be accomplished by means of hard work and much care.

But, curiously enough, once this completely exhausted sub-soil has come to the surface, only further erosion can save the situation. For the layer of senile soil which has come to the top must be washed away, so as to expose a more juvenile layer as a suitable bearer of a new cycle of vegetation, either wild or cultivated. Be that as it may, however, as long as there is natural wood humus left in the soil of the tropics, erosion there is as great a calamity as it is in temperate climates (U.S.A.).

Furthermore, in certain parts of the archipelago — on the Small Sunda Islands, for instance — there are clear signs of wind erosion as well as water erosion. This, too, carries away much of the top-soil at times, when the land has become thoroughly dried out, cracked and crumbly after a long East monsoon. Heavy clay soil which is fairly well able to withstand the action of rain-water flowing over its surface, falls a prey to strong winds during the dry season and is blown away as dust.

So far we have only spoken of impoverishment — and occasional enrichment — of arable land by the top-soil being carried away. But the opposite often occurs too. The wind — and even more frequently running water — supplies new soil here and there by covering certain areas with sand and dust or silt and clay. Whether the contribution so obtained improves the land or not, depends on the quality of the new soil-covering material and this again depends on whether the imported elements come from a region where surface erosion prevails generally, *i.e.*, affects the whole surface equally, or from one where this erosion takes the form of gullying. In the former case the silt carried by the water will consist chiefly of fertile top-soil; in the latter it is as a rule barren material brought to the surface from some considerable depth. Where the silt is likely to be fertile, an effort will be made to promote flooding as much as possible, while keeping it entirely under control by means of technically well-constructed irrigation works; where it consists of barren material, precautionary measures will be taken to prevent flooding as much as may be, and irrigation will be resorted to but sparingly and with special care.

All factors mentioned hitherto as contributing to the postponement or prevention of the complete exhaustion of the wet soil of the tropics are really subsidiary to one radical factor which may at any time suddenly bring about a fundamental change in the whole situation, namely, the action of young volcanoes. By this we mean the action of volcanoes that are young, not in the geological sense of belonging to the quarternary, in this case the holocene period, but in the sense that they have been active within the historical period, and preferably so young that they have been active during the present century — are active still, in fact.

In the Indies such volcanoes are chiefly found in Java, but there are also some in Bali and Lombok and on some of the other Small Sunda Islands, in Celebes, and finally, in certain parts of

Sumatra. These all belong to the type which eject great quantities of ashes, sand and stones over the surrounding country. This means thorough rejuvenation of the soil in the areas concerned.

At first everything in the immediate neighbourhood of the centre of eruption, on the slopes of the mountain, is in ruins, buried under all those ejecta. But it is surprising how quickly a new surface becomes covered with a fresh mantle of vegetation. A quarter of a century is often sufficient to bring this about. This fact was noted in connection with the eruption of Krakatau in 1883, of Klut in 1902 and again in 1919. If there is no immediate recurrence of the eruption, the new soil remains extraordinarily fertile for centuries, to be finally subjected once more to gradual impoverishment as a result of leaching by tropical rains.

Hence we may fitly apply the old Latin adage to the soil of the tropics in the more limited sense referred to at the beginning of this article: "Igne natura renovatur integra." Lacking that volcanic fire, the soil would deteriorate completely, whether slowly or quickly, and the means at man's disposal for counteracting this process of impoverishment are, after all, only makeshifts, important though they be from our human standpoint.

Soil conditions actually obtaining in the Netherlands Indies and, *mutatis mutandis*, in other tropical areas in Asia and South America corroborate the views roughly outlined above.

It is no mere fortuitous circumstance that Java is the most highly developed of all the islands, but the inevitable outcome of natural conditions. A considerable number of volcanoes which have been active within recent centuries, or even decades, have repeatedly brought about complete rejuvenation of the soil of the surrounding country. Here in Java we find cinchona and tea plantations — both very exacting cultures — on the slopes of the volcanoes, and on the plains at their foot — thanks to the highly developed irrigation system — rice, sugar and several other crops. But those parts of the island which lie beyond the sphere of volcanic influence are obviously several degrees less valuable from the agricultural point of view. Fortunately such areas are comparatively rare in Java.

In Sumatra the distribution is different. There, fine volcanic areas are in the minority, occurring only in the North in the Battaklands and Deli; in the central portion along the Western coast and in the highlands of Padang; and in South Sumatra in the Palembang highlands; but all these added together form but a small fraction of this great island. Furthermore in comparing Sumatra with Java, we must remember two things: Firstly, that the dry East monsoon only touches the Southern portion of Sumatra, and only reaches it when much reduced in strength. Hence the leaching of the soil is continuous in these regions, for there is scarcely a spot where an average rainfall lower than 100 mm. is ever registered for any month of the year whatever. Secondly, not all volcanic products are of the same nature. In Sumatra the ejecta often belong to the more "acid" type, while in Java they are more "basic"; which means that in Sumatra they contain more silicic acid, in Java more calcium, magnesia, iron and phosphoric acid. Furthermore, in Java potassium is found in a more easily assimilable form than in Sumatra. In short, the ejecta in Java are more fertile and produce better soil for agricultural purposes than those of Sumatra. If the reader should be inclined to observe that there are volcanic areas on the latter island not included in the above list, he should remember that these are the districts where the acid ejecta predominate.

From the above it follows — particularly if we consider that vast areas in Sumatra are entirely outside the range of volcanic influence — that this island as a whole will never be as fertile or as intensively cultivated as Java, unless, indeed, countless volcances become active there and thus rejuvenate and improve the soil by scattering first-class volcanic ash over it, as for instance Krakatau did all over the Southernmost portions of Sumatra, when it erupted in 1883. Sixty-five years ago the Lampong Districts were territory in which there was very little doing; since 1883 this region has revived; it is being developed agriculturally; European enterprises flourish there and we find immigration from Java to join already prosperous "colonies" of migrants from that island. The impulse that led to all this activity was given by the volcano.

Celebes differs in many respects from both Java and Sumatra. There, too, we find young volcanic areas, chiefly in the North Eastern peninsula, or the Minahasa, and these produce fertile soil. The same may be said of the South Western peninsula. As might be expected, these are the most prosperous and most densely populated parts of the island. The remaining portions, namely, the central part with its two protrusions extending North East and South East respectively, possess no volcanoes, nor any agriculture to speak of — at most coco-nut groves here and there along the coast — because the soil there does not encourage agriculture. And the population is much less dense here than in the Minahasa and the S.S.W. portion of the island.

Now if we look at Borneo and New Guinea — we are considering only the Netherlands section of the latter — we find that these two islands are entirely devoid of volcanoes. No need to search for juvenile volcanic soil-types there, for there are none. Nowhere is the soil of such a character that it could be used without previous special preparation to grow food crops for a number of consecutive years. There are areas that present the necessary physical characteristics but all the soil has reached an advanced state of senility as a result of continuous leaching. Rubber trees and the like demand very little from their surroundings and will grow on the recently deposited alluvial soil as it is, but in almost all other cases a crop needs manure, either animal or artificial. Under these circumstances only crops that furnish highly valuable products can be made to pay, and even then there comes a time when previously effective measures prove vain. A case in point is the now extinct tobacco-growing industry in British North Borneo. Where at an earlier date the jungle was forced to make room for plantations, the jungle has once more made good its claim to the land.

To comment on all the other islands of the archipelago would lead us far beyond the scope of this article. We will mention only one or two points. It is interesting to note that in the early days the Netherlands United East India Company settled in the Moluccas, on the islands of Ternate, Tidore, Ambon and Banda. The object was to cultivate valuable spices such as cloves,

nutmeg and mace. Curiously enough, all these islands are volcanic. Buru, Ceram and Misool are much larger, but not volcanic, and these the company ignored.

In the Small Sunda Islands group we have Bali dominated by Mount Batur, Lombok by Mount Rinjani. These two volcanoes have provided their respective territories with first-rate juvenile soil, on which has arisen a dense, prosperous and highly cultivated population. Sumba, on the other hand, has had very little volcanic influence, its dreary, desert-like wastes being composed chiefly of bare, calcareous rocks. All there is of good soil is washed or blown from the highlands into the lowlands and hence we find, besides the very poor, utterly deserted areas mentioned above, also fairly prosperous plains.

The above may be summarized as follows: It is true that a fall of rain may be a blessing to an agricultural area parched from drought, but it is equally true that in the tropical zone in the narrower sense of the term — the zone in which the Netherlands Indies are situated — too much rain is bad and, further, that abundant rainfall is the cause of continually increasing impoverishment of the soil. The only regeneration of the soil that spells radical improvement is that produced by volcanoes. Without active volcanoes the future can only mean retrogression. But retrogression may be greatly retarded and counteracted by human action. This last is the splendid task of the science of agriculture. Much has already been achieved along this line, and probably much more will be achieved in the future.

# THE RELATION BETWEEN SOIL AND POPULATION DENSITY IN THE NETHERLANDS INDIES

*by*

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If we wish to make a study of the relation between population density and soil, we must confine ourselves to regions where the distribution is not dependent, or at least not altogether dependent, on means of subsistance which are entirely, or almost entirely, independent of the nature of the soil, such as trade (import-trade, export-trade, transit-trade); mining; industry based on mined raw materials, or on materials brought from a distance and the like. We must confine ourselves, then, to *specifically agricultural areas, where agriculture and horticulture and forestry are the only, or at least by far the most important, means of earning a living.*

As the Netherlands Indies is still at the present time largely an agricultural region of this kind, it is a particularly suitable object of study in connection with our problem. Thanks to the excellent Census, taken in 1930,[1] we know fairly well what the population is in different parts of the archipelago. These figures show that the density varies from less than one to more than a thousand souls per km². In other words the differences are enormous. Hence to treat the whole archipelago as if it were a uniform area and could be studied as such is out of the question.

For, while the average for the whole territory is put at 31.89, we find Java and Madura running up to 316.11 and on the other hand, the Outer Provinces falling to 10.73 — a surprising contrast indeed. And within the Outer Provinces themselves we meet with very great differences. For Bali and Lombok the figure is 175.18, for Celebes 22.39, for Sumatra 17.43 and then again there is Borneo with 4.02 and New Guinea with 0.73. Hence we will consider the islands and islands groups separately first and then finally compare these very greatly varying territories with each other.

1. JAVA. If we examine the large volumes containing the Census Returns for 1930, we find that to each of its several parts dealing with West Java (I), Central Java (II) and East Java plus Madura (III) is appended a map on which the country is divided into administrational units called districts and coloured in eight shades indicating population density. Those who do not know Java and its soil will learn little from those maps and see nothing but colours showing that the population is very dense in and around the big cities, and further, that there are certain districts where there are less than 75 inhabitants per km²; many where there are between 150 and 500, and several with between 500 and 1000 although they do not include a large city. But as soon as we begin to notice the topography and geology of Java, the climate and the soil types of the different parts of the island, these maps begin to take on a greater significance for us.

In general we may assume that where the soil is good and fertile, agricultural crops will bring in a rich harvest, with the result that the population which cultivated them is not only satisfied with past success, but is, further, inspired to bring more and more land under cultivation. If on the other hand the harvest is poor, the tendency will be to cultivate more intensively or to move away to another place where more success may be anticipated.

On the island of Java — and as we shall see later, this really applies to the whole of the Netherlands Indies — experience has shown that *the most fertile soil types are related to volcanoes.* We find them on their slopes, at their base and in the basins of rivers, the water and silt of which comes from a volcano. But such volcanoes must be *recent*, must have been active within the most recent geological period or be *active still.* Old volcanoes are covered with more or less worn-out, senile soil, which, still cultivable and physically good for vegetation, is very much impoverished. On and round a recent volcano the soil is usually composed of or derived from volcanic ashes and sand, in fact often contains

* Reprinted from *Comptes Rendus du Congrès International* [illegible] *msterdam, 1938*, Tome Deuxième, Section [illegible] (1938).

[1] The Report is being published in a series of volumes, the first of which appeared in 1933.

little else as yet in the way of newly formed soil material. Such juvenilê volcanic ash-soils are extraordinary rich. Is it any wonder, then, that people risk the dangers of another eruption and eagerly choose such land to settle on?

Now steep slopes are always more difficult to bring under cultivation and also to live on than plains; it is therefore that the more level river-lowlands at the foot of the volcanoes are preferred to their slopes. Moreover, as a rule, the plains get more sunshine; this is a matter of direct importance to the vegetation, but it is also indirectly significant, for the reason that the fertility of the soil is promoted thereby.

The following districts in West Java (see table) illustrate the above. The most juvenile soils, not even turned brown yet, are to be found in (9) to (14); most weather-worn and lixiviated (by heavy rains!) are those of (6) to (8). Noteworthy are the corresponding population densities of the surroundings of the larger towns such as Sukabumi, Tjimahi, Garut, Madjalengka, to which Tjandjur (500), Buitenzorg (577) and Mr. Cornelis (550) may be added. Such a correspondence might indicate that the said figures were due more to the vicinity of a large town. But that would mean that in Central and East Java and elsewhere, too, the same figures would be found in the neighbourhood of large towns. This is, however, by no means the case. Take the following districts, for instance (capitals excluded):

| Volcanoes | Districts on slopes | Population | Remarks |
|---|---|---|---|
| Gedeh | (1) Tjibadak<br>(2) Tjiawi<br>(3) Patjet<br>(4) Tjibeber<br>(5) Sukabumi | 296<br>312<br>292<br>315<br>562* | The Gedeh-soils are no longer fully juvenile. The districts (1), (3) and (4) include also many older non-Gedeh-soils. (5), even if the capital is excluded, is high on account of the vicinity of this large town (vegetable and flower culture). |
| Tangkuban Prahu | (6) Tjikalongwetan<br>(7) Purwakarta<br>(8) Segalaherang<br>(9) Lembang<br>(10) Tjimahi | 198<br>189<br>191<br>441<br>371* | The northern slopes of the Tangkuban Prahu are already rather senile; rejuvenescences have taken place to the South in the direction of (9) and (10). (9) lies higher, with potatoe and vegetable culture; (10) has more plains and, moreover, has the garrison as an outlet. |
| Guntur | (11) Leles<br>(12) Trogong | 452<br>514 | Both districts have sawahs with splendid yields; besides fish culture. |
| Galunggung | (13) Garut<br>(14) Tasikmalaya<br>(15) Tjiawi<br>(16) Singaparna | 552*<br>637*<br>476<br>317. | (13) and (14) have more plains than (15) and (16). (16) lies high and is accidented, includes also non-Galunggung-soils, but all soils are volcanic. |
| Tjerimai | (17) Madjalengka<br>(18) Radjagaluh<br>(19) Tjilimus<br>(20) Kuningan<br>(21) Telaga | 530*<br>520<br>368<br>354<br>437 | (17) and (18) have more lowlands. Besides rice, sugar is already cultivated here. But (17), like (19), (20) and (21), already includes some bad tertiary areas. |

* These figures for the districts have been recalculated after deduction of the population of the municipalities and towns, and naturally the area of these.

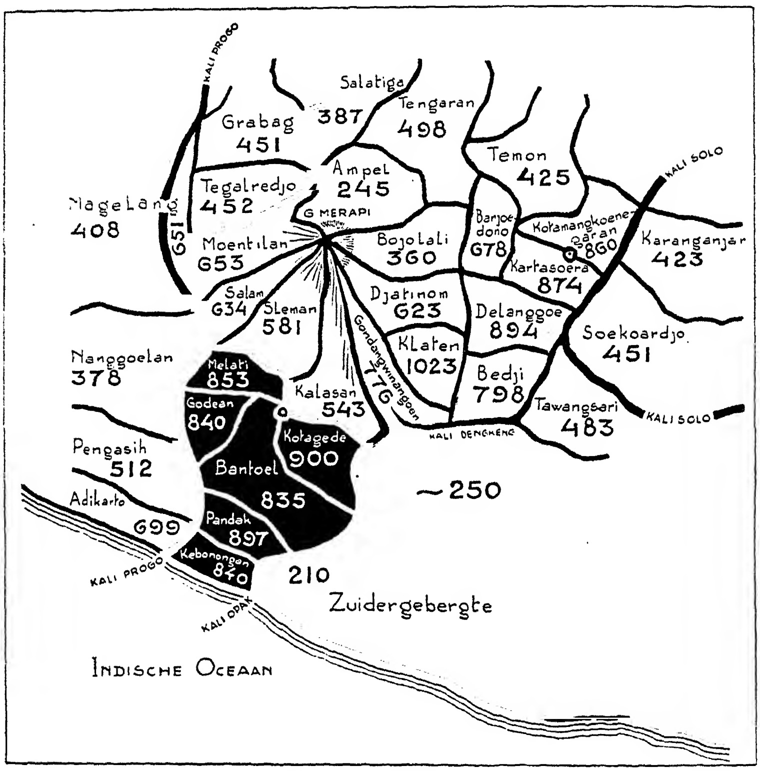
| | | | |
|---|---|---|---|
| Slawi | 797 | Ambarawa | 368 |
| Tegal | 1052 | Salatiga | 387 |
| Pekalongan | 1486 | Boyolali | 360 |
| Purbolinggo | 712 | Sragen | 353 |
| Sukaradja | 746 | Blora | 305 |
| Kebumen | 795 | Tjepuh | 236 |
| Purworedjo | 837 | Bodjonegoro | 232 |
| Klaten | 1023 | Tuban | 312 |
| Kudus | 900 | Lamongan | 341 |
| Tulungagung | 770 | Paree | 335 |
| Probolinggo | 710 | Bondowoso | 278. |

Although, as we have seen, the fact that it contains a fairly large town, does influence the density of the population of the district, yet *in Java the nature of the soil is a more important factor.* Witness the following facts: Slawi and Tegal derive their fertility from the young volcano, Slamat, via the river Kali Gung; Purbolinggo and Sukaradja lie on that same mountain's southeastern spur; Klaten has the finest Merapi-soil, Tulungagung has the same fine soil derived from Klut and Probolinggo gets it from the Lamongan volcano. On the other hand Ambarawa and Salatiga are on older volcanic soil; Blora, Tjepuh, Tuban, Bodjonegoro and Lamongan in a tertiary area, far away from the nearest volcano. At Paree the soil is composed of Klut-ejecta; these are not fine as in Tulungagung however, but more sandy and stony. Not so easy to irrigate either, and, besides, rather too juvenile. Hence *the figure for each district can be explained on the ground of the nature of the soil combined with climatic conditions.* But there are exceptional cases too. For instance: the high figure for Pekalongan and the surrounding country is certainly due to the batik industry located there, and that of Kudus to the native cigaret industry. More significant still in this connection is that between Slawi and Tegal there lies the Adiwerno district, completely irrigated but not including a single large town. The population density there is 1638 — the highest of any country district in the Netherlands Indies. Without *Slamat's* good gifts such a numerous population would be out of question there.

As a matter of fact these good gifts of Slamat's, and also those of the Diëng volcanoes, were carried southwards with the waters of the river Serayu to the sea. And the sea gave them back to the land in the form of sand and dunes along the coast from Maos on far to the Eastward. Further on other rivers worked to the same end, with the result that along the whole South coast from Maos to Djocja all the coastal districts show an average density of between 500 and 900. Eastward and westward Slamat could hardly shed its beneficence because of the presence of older highlands. Hence we find districts there with only from 300 to 400 inhabitants per km.[2]

The country surrounding the *Merapi* is an-

other remarkable case. This volcano, the last eruption of which was only seven years ago, has recently sent its ashes, sand and stones more especially in a westerly to south-westerly direction; to the North lies Gunung Merbabu, barring the way and to the East a ringwall, over which only light, powdered ejecta can be carried to cover the land as aerial deposits. Round the foot run the rivers which sort out the young fertile soil-ingredients and deposit them again as alluvial types of soil still more fertile than that found on the mountain slopes; to the West runs bacco culture in the Native States). On the eastern banks of the rivers Kali Denkeng and Kali Solo the density suddenly drops from more than 800 to less than 500 — much less ash from the Merapi reached this area. Nor does the density exceed 500 in the highlands to the North. The proximity of the large town of Surakarta does not seem to influence the situation; neither does Magelang affect the surrounding country; all depends on the volcanic products — on the soil; and rivers act as frontierlines even in the matter of density of population.




— FIGURE 71 (*see* p. 256) —

the Progo, to the South the Opak, to the East the Denkeng and Solo rivers. To the North there is none. And now for the comparative density of the population (see Fig. 71).

To the South and South West, where the youngest sand and block streams came we see a density ranging between 543 and 653 (1); more to the South on the alluvial soil, from 800 to 900; westwards from here, across the Progo valley, 378 to 500, and then along the coast the figures rise once more. On the eastern slopes the density is 600, above these 400 and on the saddle between Merapi and Merbabu, where there is extensive forest reserve which moreover the youngest ashes did not reach, only 245. At the foot the figures rise to 800 or even to more than 1000 (Klaten, the centre of the to-

Typical, too, in this connection is the course of the river *Brantas*, especially there where, near Blitar, the ejecta from Klut enter its waters, to be sorted or mixed and then deposited again. The extensive higher portions of Srengat, Ngadiluweh and Paree are as yet too arid on account of excessive sand, gravel and stones to bring the average higher than about 400. Along the Brantas the figure is higher (Tulung Agung (770*),[2] Kediri (490*), but then come Papar (610); Warudjajeng (721); Kertosono (609*), Djombang (672*), Modjoagung (637); Modjokerto (556*), Krian (703), Taman (617), Si-

[2] An asterisk means that, as mentioned before, the figure in question has been arrived at after the population and the area of the (main town) capital of the district have been subtracted from the total population and the total area.

doardjo (455), Modjoasri (541), Porong (696), Gempol (656), Bangil (479*). Both to the North and to the South of this series the figures are below (400), and in the tertiary marls of the adjacent Gunung Kendeng even below 200.

Above we spoke of the beneficent effect of volcanoes. But not all volcanoes are the same. The above mentioned ones all provide *basic* rock, with much lime, magnesia, iron, potassium, phosphoric acid in them. But volcanoes often produce *acid* rocks containing much silicic acid, little lime and little iron. The soil derived from such rocks is in general physically less loose and often very sticky and heavy; chemically less rich, too. In Java there is only one region in which such rocks occur to any great extent, namely *Bantam*. Where they predominate the fertility of the soil, hence the agricultural returns, hence the density of the population is naturally less than it would have been if the rocks had been of the same nature as those derived from Galunggung or Slamat or Merapi or Klut. The following districts illustrate this: Pamarayan 291, Rankasbitung 173, Lebak 79, Parungkudjang 66, Tjilangkahan 47 and Tjibaliyung 20 — this last being the lowest figure for Java.

The poverty of the soil in these last mentioned districts is due partly to the fact that the bleached Bantam tuffs are already primarily poor in plant food, and partly to the *climate*. There is a yearly rainfall here of between 3 and 5 m and this leaches the soil thoroughly. *With such a rainfall the soil must be very juvenile to produce enough food for the population*, and since there are few instances of such juvenile soil in the world, it is safe to say that *areas where heavy rain falls throughout the year are as a rule but sparsely populated*. Even soil which was originally very rich, on the slopes of a volcano for instance, must, under such climatic circumstances, decrease in fertility so greatly, as soon as the virile stage is passed and it has become more or less senile, that the population decreases too. The northern slopes of the Diëng highlands are a case in point: on these slopes and adjacent to the very densely populated lowlands of Pekalongan (Wiradessa (979), Pekalongan (1486*), Batang (601*), Kedungwuni (929)) lie Doro with 142, Bandar with 246, Bawang with 238, and the yearly rainfall there is 3½ to 7 m! The northern slopes of Tangkuban Prahu already mentioned in the first table show population density figures below 200 on account of this same excessive rainfall.

We may say, then, that the above italicized line may be expanded as follows: *Within certain limits, the less rainfall the more fertile the soil and the denser the population.* This fertility is more stable, less apt to be a passing phase. Naturally this reduction of rainfall must not go too far. It must not proceed to the point where there is insufficient moisture for the food crops, so that these might consequently suffer and finally die from drought.

In order to correct unfavourable conditions in regard to water supply, the cultivator, in the present case the native of the Netherlands Indies applies *irrigation*. The table below will serve to make clearer the effects of this irrigation:

| In general *too much* rain water | | In general *sufficient* rain water | In general *too little* rain water | |
|---|---|---|---|---|
| Soil grows poorer | | soil grows poor in the long run; some years there is drought | vegetation suffers and finally dies from drought | |
| Irrigation to provide *plant food* | | Irrigation *to insure* successful *harvest* | Irrigation to provide *water* | |
| impossible | possible | effect variable | impossible | possible |
| population sparse | population fairly to very dense | population density medium | population sparse | population dense to very dense |
| (1) | (2) | (3) | (4) | (5) |

Here we note:

in (1). There are two reasons for the fact that it is impossible to use irrigation as a means for providing the lacking food crops.

a. The land is convex in all directions consisting of ridges and hillocks, on which irrigation water cannot be brought. For examples from Bantam see above. Lime plateaux in South Prianger, namely, Djampangkulon 64, Sindanbarang 42, Bungbulang 57, Pameungpeuk 55, Karangnunggal 88, Tjikatomas 92, Tjidjulang 79, fall under the same head. Also Tjilatjap 175, one of the lowest averages in Central Java, and Panggul 139 in South Kediri as well as the Southeastern part of Genteng 111, almost uninhabited.

b. Water can be brought up, but this water itself comes from areas where the soil is poor and therefore it contains little plant food or none. A case of this kind hardly ever occurs in Java, but in the Outer Provinces (Sumatra, Borneo and New Guinea) it is fairly common. Conclusion: irrigation is useless.

In (2). If irrigation is applied in areas where the soil is worn out and poor as a result of much rainfall and the water introduced is derived from young highlands (volcanic peaks), very great success is sometimes achieved. Instances of this are: Buitenzorg 577*, Sukabumi 562*, Tasikmalaya 637*, Madyalengka 530*, etc.

In (3). If the soil is already old and more or less worn out, the case is in line with that indicated under (2) and then irrigation is certainly beneficent, especially as a means of supplying plant food, even when the rainfall is not over 4 m annually but about 2 m. In regions where the average yearly rainfall is sufficient in the long run but an occasional year of drought has to be reckoned with, irrigation is undoubtedly a blessing as a defense against crop-failure, in that it ensures a satisfactory water supply anyhow. These conditions are found in many districts where the population density figures are between 250 and 450.

In (4). It is impossible to create a water supply where there simply is no water available. But this condition of things is not found anywhere in Java. In the most arid parts of the

island there is an average rainfall of 800 mm. There are years occasionally when it is only 400 mm or even a little less, but these are exceptions.

Yet there are parts of Java in the extreme North East of the island which cannot be irrigated, or rather, where there is no irrigation and where no rain falls for six, or sometimes eight months. One of these is the Sumberwaru district, where the population is 87 per km², although the soil would surely be fertile, if only there were water. On the Small Sunda Islands are areas of this character, which are more arid still and more thinly populated.

In (5). In cases where it is possible, thanks to high mountains in the hinterland, to bring irrigation water to a relatively arid region where the soil is rich we find the greatest fertility. Along the North Coast of East Java, where the rainfall is less than 1½ metres, it is irrigation, and the very extensive cultivation of sugar, which this has made feasible, which are responsible for the density of the population in Pasuruan (656*), Probolinggo (710*), and Sitobondo (510*). Back of these and at a slightly higher altitude are districts which are not irrigable and which in spite of the fact that they get a little more rain, show a very much lower average population density. There are: Tengger (Pas.) 149, Tengger (Prob.) 127, Gading 130, Pradjekan 115. The population of the last named is practically speaking all settled along the river Sampean.

Sugar-growing, which is economically dependent on high yield of cane and high returns of sugar, is chiefly restricted to areas falling under (5) with naturally rich, volcanic soils; and because it involves so much hand-labour, it accentuates the population figures still further.

The topography of a district does the same, in the sense, that much level ground increases the average, whereas a rather hilly region decreases it, especially where large tracts of this highland country are wooded and reserved in the interests of irrigation.

All the various factors so far discussed combine to produce a striking correlation between the density of the population and the percentage of the surface of a district, that is under cultivation; and, secondarily, how much of this has been made into sawahs, *i.e.* wet rice fields. The graph on p. 259 shows the mutual relation of these two factors in a considerable number of districts. The population figures are those quoted in the Census Returns for 1930. The percentages are from the tables given in the Agricultural Atlas published by the Government in 1926. The hyperbolic curves indicate what percentage of the total area is occupied by sawahs. Comparatively low figures are marked by a square, high figures by a circle.

The graph shows that

1. In all districts where the population is less than 100 per km², the land under cultivation is less than 30% of the total area and the sawahs less than 9%.

2. In all districts where the density of the population is more than 800 the land under cultivation is more than 50% of the total area and the sawahs more than 40%.

3. Between the high figures there appear also very low ones, and, contrariwise, high ones occur among groups of low ones; this fact is explained by difference in soil types.

The comparatively low figures in the right-hand upper section indicate that there agricultural returns are small. This is due to the fact that the soil is poor (Bantam) or bad (on marls), or else the irrigation is still insufficiently organised as in N.W. Batavia, for instance; although the population has done the best it could, under the circumstances.

The high figures found in the right-hand lower section show that in those parts irrigation was generally out of the question, as on the island of Madura. The population was forced, by want, to make use of every square foot of land. There are no more forests, nor wood for fuel. The people are partly dependent on salt-making and other industries for a living. They make what they can out of growing maize. Manuring the ground is no use as the water supply is the minimum factor.

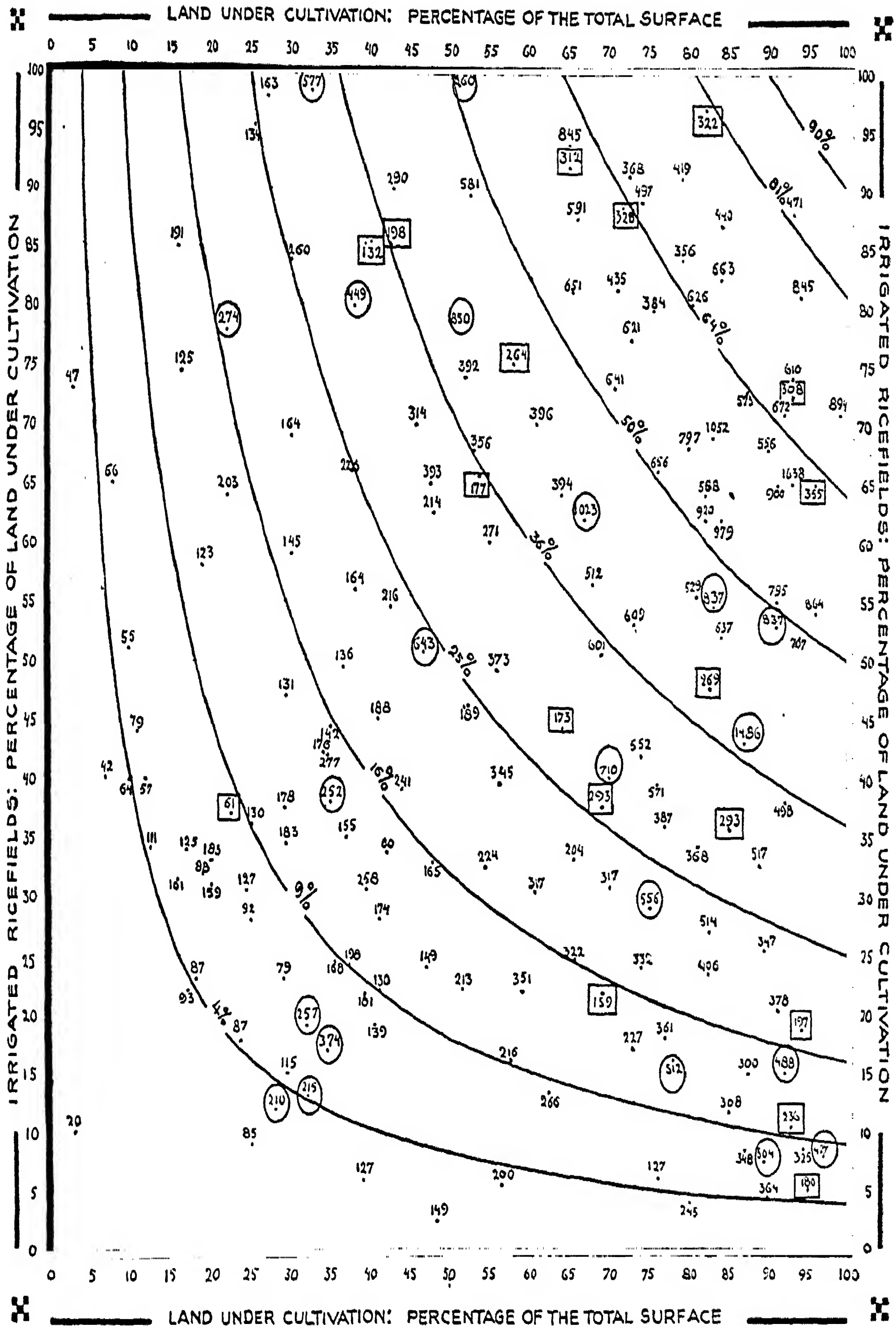
Where we find comparatively high figures in the left-hand lower section, that means that the districts concerned are situated in the lime area of the Gunung Sewu. It is difficult to lay out rice fields there, as it is in Madura, but the limestone soil is not unfertile. Besides the population can, if need arises, migrate to the rich agricultural lands of the Native States of Central Java.

Where in the upper portion of the graph, between 20 and 55%, several high figures are found among low ones then these apply to districts where the soil is fertile, but which include a large amount of forest reserve, which means that a comparatively small area is under cultivation. Areas where large tracts of highlands are occupied by European plantations, are also thinly populated and show densities between 200 and 400.

We see, then, that it is possible to trace and point out the correlation between the density of the population in any given district and (a) the nature of the soil and (b) hydrographic conditions, (c) the resulting use of the soil and (d) the agricultural returns.

To go into the question of these returns in detail would take us too far afield. Suffice it to say the average yield of padi, when the harvest is successful, ranges between 8½ and 44 piculs per bahu;[3] and that, since density of the population depends on the amount of available food, which, again, depends on the yield of the cultivable land, *i.e.*, the sawahs, these yield figures must correlate with the different densities. Below are figures for a series of *adjacent districts:*

| Districts | Padi yield picul per bahu | Population density | Districts | Padi yield picul per bahu | Population density |
|---|---|---|---|---|---|
| Pandeglang + Tjimanuk | 35½ | 293 | Modjoagung | 44 | 637 |
| Menes | 28½ | 136 | Ploso | 19 | 274 |
| Parungkudjang | 21½ | 66 | Ngimbang (Mantup) | 14 | 163 |
| Bumiaju | 35½ | 441 | Krian (+ Bulang) | 38½ | 703 |
| Madjenang | 23½ | 149 | Gunung Kendeng | 15 | 412 |




— FIGURE 72 (*see* p. 258) —

We must be careful, however, in interpreting these figures, as often possibilities for occupancy exert a greater influence on the density of the population than the differences in the yielding power of the soil.

It would be difficult to point out districts in Java where there is no volcanic influence at all. Those in the Southern portion of the Priangan Residencies and those North of the Salatiga-Modjokerto line approach most nearly to this condition. In the former, which are in a tertiary marl and limestone area, the density remains less than 100; in the latter, which include many teak forests on ridges of calcareous rock and marl, the averages range between 130 and 300. These figures never rise to the level of those for better, volcanic areas; on the other hand only volcanic regions where soil has already become senile all over show figures as low as 300 or less.

2. THE SMALL SUNDA ISLANDS. *Bali and Lombok.* It would be too soon to apply the standard for Java to these two Islands. For organised European Government, which Java has known for several centuries, was introduced on these islands less than half a century ago. The standard to be applied is that of the Outer Provinces, and according to that Bali and Lombok fall into the class of the most densely populated areas, thanks to the predominant influence of young volcanoes and excellent irrigation. The sub-section of Gianjar has more than 450; the figures for the other southern sub-sections range between roughly 190 and 380, according to the amount of sparsely populated, wooded highlands or arid limestone tracts they include. The Northern portion is very much affected by the very dry East monsoon; owing to the fact that for six months of the year there is no rain, the population density is only just above 100.

We may say that in general during the East monsoon the northern slopes of the Small Sunda Islands suffer from drought without any chance of irrigation worth mentioning; with the result that the population is less dense here than on the southern slopes, even in cases where the soil is derived from exactly the same parent material.

The Small Sunda Islands lying directly Eastward of Bali and Lombok are all much less densely populated, but then for the most part they have not the same favourable young volcanic soil or the same irrigation possibilities. They lack proper lowland tracts. There is not a single volcano in Sumba, Rotti or Timor. The population density ranges between 73 in Maumere (Flores), which is very dry but possesses young volcanoes, and less than 10 — the minimum — as in the almost desert wastes of limestone country in East Sumba.

3. SUMATRA's soil is very different from that found in Java. There is hardly a spot in Java where young volcanic influence is not present to some degree; the soil in Sumatra is for the most part much older and the recent vulcanism so common in Java only occurs here at three or four points, to be specific — the southern portion of the Lampongs, the highlands on the border of Palembang and Benkulen, the Padang Highlands and the Batak country. Nor is recent vulcanism as it occurs in Sumatra the same as that of Java; for as a rule more acid effusiva came to the surface here and only very little of the basic. Hence the population figures for these volcanic areas may be expected to correspond more nearly to those for Bantam than to those for the rest of Java. In the non-volcanic areas in Sumatra, where poor claystones, and still poorer quartz sandstones constitute the greater part of the parent material of the soil, the population may be expected to be considerably less dense. And so it is in fact. Striking examples of this are to be found both along the East coast and the West coast of the island.

In the former lies Mt. Merapi, which had several violent eruptions a century ago and has since ejected a considerable amount of fairly basic ash in numerous lesser eruptions. The sub-section in which the soil profited most by this action is Oud-Agam (in which Fort de Kock is situated), where the population density in 1930 was 237, or not counting the capital, 220 — the highest figure in the whole of Sumatra. The Fort van der Capellen sub-section, to the South East of Mt. Merapi, also shared the beneficent influence of this volcano on the soil and there the density is 169. To the North East is Suliki with 92 and Pajakumboh with 48. Beyond these sub-sections the influence is no longer discernible and we find Bankinang with 18, Kamparkiri with 2.7 and Siak with 0.9, the soil getting more and more exhausted and the inhabitants fewer and fewer, those that are left having settled exclusively along the river banks surrounded by an almost uninhabited country.

The following table presents two series of sub-sections (a) along the coast and (b) just inland from this. If the soil were equally good or equally bad in all of them they would probably not vary greatly in population density. As it is the influence of recent volcanism is plainly apparent.

We might enumerate all the divisions and sub-sections in Sumatra and we should find that almost in every case the comparative density or otherwise of the population could be accounted for by the nature of the soil, and especially by the presence or absence of recent volcanic influence. Yet there are exceptions, besides of course such cities as Palembang, which is greatly affected by commerce and shipping interests. There is Kerintji, for instance, which is not sufficiently densely populated for a sub-section with a fine volcano in it. We may reasonably expect that its density average of 18 will rise in the course of time especially since the country has been opened up during the last decades by means of new trunk roads. The fact that on the East coast the averages mentioned are less than on the West coast is accounted for the prevalence in the former region of European plantations occupying large tracts of tobacco and rubber land, whereas in the latter we find chiefly native rice fields.

4. In CELEBES conditions are very largely the same as in Sumatra. There too we find young volcanic areas, namely in southwestern Celebes, in the Minahasa and also in the Toradja country. The best of these three as far as soil goes is southwestern Celebes and there we consequently find the population density rising above 100 in several sub-sections, namely, Pangkadjene, Goa, Takalar, Djeneponto and Bontaëng. It is noteworthy, that these are the regions where the East monsoon lasts longest and is driest. The South East coast (Bulokomba, Sindjai and Wadjo) which gets more rain and

[3] 1 picul = ~ 5/8 quintal, and 1 bahu = ~ 7/10 ha.

EAST COAST OF SUMATRA

| Coastal Sub-sections (a) | Volcanic influence on soil | Pop. density including – excluding main town | Volcanic influence on soil | Sub-sections just inland from coast (b) |
|---|---|---|---|---|
| Tamiang | — | 17 | | |
| Lower-Langkat | + | 34 | | |
| | | 52—48 | ++ | Upper-Langkat |
| Lower-Deli | +++ | 208—139 | | |
| | | 84 | +++ | Upper-Deli |
| Serdang | ++ | 86 | | |
| Padang-Bedagei | + | 79—69 | | |
| Batubahra | + | 57 | | |
| | | 66—62 | + | Simelungun |
| Asahan | + | 36—35 | | |
| Labuanbatu | — | 14 | | |
| Bagan Si Api-api | — | 4.5—2.1 | | |

WEST COAST OF SUMATRA

| Coastal Sub-sections (a) | Volcanic influence on soil | Pop. density including – excluding main town | Volcanic influence on soil | Sub-sections just inland from coast (b) |
|---|---|---|---|---|
| Natal | — | 8 | | |
| Ophir | + | 14 | | |
| Manindjau | ++ | 72 | | |
| | | 237—220 | +++ | Old-Agam |
| | | 169 | +++ | Fort v/d. Capellen |
| Pariaman | ++ | 169 | | |
| | | 152—132 | ++ | Padangpandjang |
| Padang | + | 204—139 | | |
| | | 99—94 | + | Solok |
| Painan | + | 38 | | |
| | | 13 | + | Muaralabu |
| Kerintji | ++ | 18 | | |
| | | 9 | — | Muarabungo |
| Muko-muko | — | 5 | | |

where therefore the soil is more worn-out and leached, has no sub-section with an average density of more than 90. If we look at the peninsula of southwestern Celebes and regard it as a unit, we see in the South the great volcano named Lompobatang, in the central region from Maros to Pare-Pare basic leucite rock, and in the North the Toradja volcanic highlands. For this area as a whole the population density average is about 73.

For the Minahasa, the highly volcanic northeastern promontory of Celebes, the figure almost is 60; for the rest of Celebes, which is not volcanic the average density is less than 5 inh. p. km².

The population of this island has been under European rule for about thirty years and during this period it has increased considerably. No doubt this growth will continue for a while at least, but the increase in those areas where the soil is good and fertile as being derived from recent volcanic material will be relatively much greater than that in areas where the soil is so poor, that the people living there have the greatest difficulty to wrest a living from it.

5. In BORNEO there is not a single young and active volcano. We may therefore expect to find the average density of the population lower than it is in either Sumatra or Celebes. In point of fact the figure for Dutch Borneo as a whole is 4. In the West Division (average 5½) we find Singkawang showing an average of 16½. But then, investigation has disclosed the presence there at several points of old volcanic parent material of the soil. Pontianak has but little of this; hence its figure is 9. Ketapang and Sintang have none at all and therefore never and nowhere rise above about 2½. The South and East Division of Borneo (average 3½) includes one area that is better than the rest, namely Ulu Sungei with a density of 47. During the East monsoon this region is in the rain-shadow of a ridge of mountains or rather a series of three or four ridges running from S.W. to N.E. and hence enjoys a definitely dry season — which is an exception on this island. As a result the soil is less leached and more fertile. Furthermore the rocks of the ridges just mentioned include some which in the course of weathering produce an alluvial deposit rather better than the average. Consequently cultivating rice can be made to pay in this region. The yield ranges between 11 and 35 pic. p. bahu, the average being 20½ pic. p. bahu. In Java this average would certainly be 5 pic. higher; in some parts of East Java, and in the Padang Highlands we should find it doubled.

The rest of the South and East Division is very sparsely populated. If we leave out of consideration the sub-division where there are coal mines and oil wells, there are 515,000 souls inhabiting a good 360,000 km², which means a density of 1.4. Extensive forests and fields of grass vegetation cover the mountains, hills, plains and marshes. All this country is uncultivated. The population lives only along the banks of the rivers.

6. Among THE MOLUCCAS there are a few islands which are partly or entirely volcanic, and boast a population which may be called comparatively plentiful. These are Ambon and Saparua (82 and 81), Banda (70), Ternate (32). The rest have figures below five.

7. Finally we come to NEW GUINEA. We know of no young volcanoes in the section belonging to the Netherlands. Old volcanic rocks are found sporadically. The parent rocks of the soil are for the most part sedimentary, tertiary and older; the relatively driest areas are the North coast and the South East coast. In the plains we find heavy but not really fertile, clay. This explains why the average density of the population does not exceed anywhere 2, the average (not counting the smaller islands) being 0.73.

To sum up, then, we might state the case for *the whole of the Netherlands Indies Archipelago*, and in fact for the tropics in general, as follows:

The richer the rocks, or parent material of the soil, are in plant-food, the more fertile the soil will be. Intermediary to basic volcanic rocks are the very best; next in order come the more

acid rocks; then limestone with admixtures; then marls, which often produce chemically rich but physically unmanageable, heavy clay; and finally quartz sandstone that makes only poor soil.

The more disintegrated the rock material before subjected to chemical weathering, the more quickly it is transformed into soil — rich soil. In this respect there is nothing so good as volcanic ash. Solid and compact rocks weather slowly.

Heavy rainfall at a high temperature not only wets the soil but leaches it out as well. If the latter forms slowly, it is leached out the moment it is formed and is therefore poor. It is only where the weathering takes place quickly and the soil is formed rapidly that rich, fertile soil as a temporary phase (even if this lasts for several centuries) is possible in the tropics. Hence, only on volcanic ash, sand or tuff. In the course of time even such soil becomes impoverished by leaching.

A dry monsoon retards leaching and impoverishment; little rainfall does this even more. Fertility depends then on whether or not it is possible to irrigate. Where irrigation can be achieved, the maximum fertility can be obtained. The fertility is enhanced by plenty of sunshine and warmth.

The Netherlands Indies demonstrates all this with its population figures ranging from 0 to more than 1600 souls per km$^2$. Java has the highest averages, East Java and Central Java showing relatively higher figures than West Java, which possesses fewer active volcanoes and a higher rainfall. East Java, Bali, Lombok and even S.W. Celebes should be grouped together as possessing many characteristics in common. Sumbawa and Flores fall out of line somewhat. We may therefore perhaps expect that these islands will be able to develop considerably in the future, if and when reforestation of the hills and irrigation of the plains have been successfully carried out. The Minahasa, too, will be able to support a larger population in the course of time. The sub-sections of Tobelo and Djailolo on the island of Halmaheira and also Ternate, all three possessing young volcanic soil and having an average population density of 4.4 — 11.9 and 31.6 respectively, are too thinly populated in view of the nature of their soil. One suspects that this is due to the bad health prevalent among the people. As hygienic conditions improve, the plains are better drained, and reforestation proceeds in the highlands, and so forth, this part of the Moluccas will be able to offer a living to a larger population, though it may never become a second Bali.

What one volcanic eruption can accomplish may be seen in the Lampongs (S. Sumatra). Before 1883 (eruption of Krakatau!) this was a poor country without much vitality; after that date it showed remarkable signs of new life both in regard to native and European agriculture.

Agriculturally speaking Madura is on the borderline of overpopulation. In that island the salt industry must be depended on to keep the population alive and every year migrations to Java are necessary, just as the people are forced by circumstances to migrate to Burma from certain parts of British India. The Madurese do not migrate to Borneo, Central-Celebes, Ceram or New Guinea, however, for, to put it bluntly, this would not pay. It could only pay if one of two things happened. Either a volcano would have to suddenly become active in those regions and cover the land far and wide with a fertile layer of ashes; or the cultural standard would have to rise to such a degree that these countries came to occupy the same agricultural level as, for instance, the Netherlands, where the poorest soil can be made fertile by the use of mineral fertilisers or manure of home or foreign manufacture, and where all the best agricultural methods are applied. But these are dreams that could only be realised in a far distant future — perhaps they are not realisable at all. For the present, then, and for many a long year to come, the fact remains that *in the Netherlands Indies the population density is a function of the nature of the soil, and this is a function of the presence of active volcanoes.*

# DEVELOPMENT OF NAVAL STORES AND PULPWOOD SUPPLIED FROM THE PINUS MERCUSII OF NORTHERN SUMATRA

*by*

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In the colonization of the Netherlands East Indies the Dutch have shown a remarkable aptitude for modernization and development of natural resources under a social scheme that is almost idealistic.

While one ordinarily associates the Indies with its major capacity for cultivating rubber, coffee, tea, palm oil, etc. for export, as well as its supply of minerals and oil, many other fields are becoming rapidly investigated and developed with the aid of their splendidly equipped and well organized technical laboratories under government supervision.

Among the new projects is the rapid development of a source of gum rosin turpentine and pulpwood in northern Sumatra by a carefully controlled second growth crop of the fast growing *Pinus Mercusii* which are indigenous to the volcanic mountain slopes at elevations from 1500 to 7000 feet above sea level and almost on the equator.

**History of Pinus Mercusii:** — These pines in their virgin state occurred throughout the mountain jungle slopes considerably scattered, but running tall and straight to heights of 200 feet and 11 feet in circumference or more; their seeds generally proved unprolific in the shade of the denser hardwoods, except where sand slides cleared the growth and competition took place for reproduction between the various other species of trees.

The early native aborigines came, cleared some of this jungle, burnt it, and reburnt it to provide clearings for their fields, and feed for their cattle, or to provide an area for driving deer and other animals in their seasonal hunts; thus, the native population developed extensive grass areas for their use. The big pines scattered their seeds to these clearings and, due to their vitality and persistance, some young trees lived in a continuous battle for survival against fire. Where no fires occurred for a year or so, these young trees had a chance to develop rapidly.

**Early Investigations:** — The Achinese of northern Sumatra were the last natives to submit to colonial influence and in fact the last treaty with the native princes was not signed until 1907; however, with peace established, the colonists noted the possibilities of turpentining but it soon developed that these older trees did not offer a good commercial proposition as they had a restricted limit in tapping, their growth vitality being lowered by the fires and jungle growth, and were so scattered on the mountain slopes that transport was difficult.

Investigation by the government foresters indicated that the second growth where allowed to survive gave a much higher yield of gum and had a very rapid growth. The age of the old trees was uncertain due to the absence of annual rings, and rate of growth could only be made by observation. Such ring indications that are visible are due only to seasonal variations of more or less rain, in a climate where the temperature varies but a few degrees throughout the year, with considerable rainfall and humidity.

In 1924, the Government decided to make experiments in regard to promoting the growth of these pines for turpentining and placed the control under the Government Plantations Department, rather than the Forest Service, in view of the fact that the former had done somewhat similar work in the tapping and growing of rubber trees, etc.

The initial experiments were carried out in a slow but methodical manner for the next 9 years, demonstration forests being started with a view to a future supply of pulpwood as well as rosin and turpentine. Various other species of pines were imported and planted but none found to compare with their native stock.

**Practical Operation:** — By 1933 as a result of this pioneer work, sufficient data had been obtained to warrant the starting of a small commercial enterprise which yielded in the ensuing year 600 tons of rosin and turpentine.

In the next four years such progress and increase in yield had been made that a central distillation plant was built in 1937 at Lampahan near the foot of the old volcano Boer Tellong. This plant has a capacity of 40,000 annual tons of combined rosin and turpentine and can be expanded readily.

The gum is collected at various points in the forest area and delivered to the distillation plant in tank trucks, or drums, over an average haul of 50 miles or more. The finished product is transported by truck a distance of 140 kilometers (85 miles) to a port at Lau, Seumawe, the rosin being packed in boxes of 100 kilograms (220 pounds) and the turpentine in drums (made up at the plant from flat sheets) to hold 200 liters each.

**Capacity of Naval Stores:** — As the end of 1941 approaches, the output has been brought up to 12,000 metric tons, 75% as grade X rosin and 25% as turpentine, and 150 miles of road have been built into the forest area which is in very rugged mountainous country with pines occurring along the slopes. These roads follow the slopes in easy grades and are well surfaced for truck transportation of the raw gum.

The total net forest area under development in this particular section amounts to 280,000 acres, which is conservatively expected to give a yield

* Reprinted, with kind permission, from *Paper Trade Journal*, Apr. 16, 1942, Tappi Section, p. 186–189; based on an address presented at the annual meeting of the Technical Association of the Pulp and Paper Industry, New York City, February 16, 1942.

of 750 kg. per hectare or 680 pounds per acre per year of rosin and turps, equivalent to over 90,000 tons per year, and, in addition, pulpwood from the thinning operations will average a cord per acre per year excluding cat faces of tapped out trees which will be used for fuel. The output of pulpwood will depend on the economic ratio in value of future paper products *versus* the naval stores. Other areas will also be progressively developed in ratio of the demand.

**Pulpwood Investigations:** — In 1936, the Government Plantation Laboratories commenced to investigate the pulping possibilities of these pines, and finding it somewhat similar to those in the southern United States, sent their technical director to this country to observe the new developments and mills in the south for reduction under the kraft or sulphate process.

The difficulty to be overcome in considering a pulping operation was the question of transportation of the wood to a suitable mill site. The forest areas being in mountainous country were inaccessible to railroads for either raw materials or finished product. As they lay mostly, however, upon the slopes draining into the Djamboe Atje River, experiments were made with the idea of floating the pulpwood down this stream some 150 miles to Tenpanbate within a short distance of both port and rail facilities along the lowlands bordering the east coast of Sumatra.

At first, it was apparent that the fresh-cut pulpwood would have too great a loss in "sinkers"; however, further experimentation developed the fact that this wood could be cut, peeled, piled, and dried on the plantations to 25% moisture without deterioration; in fact, the writer saw some of this wood that had been stored in piles for over 18 months that was only then commencing to show evidence of blue stain. The test runs on river-driven wood when dried out for relatively short periods at the proper season indicated that the loss by sinking would not exceed 3%.

**Proposed Pulp and Paper Mill:** — With the demonstrated assurance that a means for transporting wood was obtainable and that it had good pulping qualities, a long fiber length, and uniformity of moisture and quality, the government decided early in 1941, in spite of unsettled world conditions, to proceed immediately with plans for a sulphate pulp and paper mill of 150 daily tons capacity, of which 75 tons will be bleached, a ready market being available for such products in the Indies for wrapping, containers, and other papers for use both in domestic consumption and export packaging. This mill and other industrial projects are to be designed and built by American engineers and contractors, and it is believed will prove to be the beginning of a substantial export trade from the United States on construction and industrial equipment, as well as supplies which in the past have gone to Germany and others.

**Forest Growth Control:** — The early demonstration tracts and subsequent commercial operations clearly developed that the yield was greater from young trees than the old, and that advantage would have to be taken of their marvelous possibilities for quick growth and that because of this rapid growth thinning had to be carried out; also, that yield was not only a function of growth and development of the stem but of the branches as well.

With good protection against fire and cattle (and even occasional elephants), the cleared land propagated from the original seed trees or from planting in bare spots forming a carpet of pines running 1000 or more to an acre, which were thinned out at least every second year in progressive stages. Within four years, from the appearance of the shoots, these trees had attained a height of from 18 to 20 feet increasing 5 feet per year up to 12 years when the growth rate decreased, attaining a height of from 50 to 70 feet, by which time the progressive thinning had brought the number of trees down to around 200 per acre, representing from 30 to 40 cords or more per acre.

A careful study of the effects of thinning out was made by dividing the demonstration forests into small tracts, each thinned at different rates and the results compiled. These studies developed several important factors; if the thinning was too great, the young trees developed too rapidly and extended their tops, while the stems tended to curve and bend, thus creating compression wood at these points. Curiously enough, the second growth shows some tendency to become crooked at all times, whereas the virgin tree was straight and tall. A fairly definite ratio of amount and period of thinning was established in relation to yield as well as growth, and data is continuously being collected.

**Tapping and Thinning Operations:** — The French or Bordeaux system of moderate faces is generally employed, roughly 2½ inches wide with several longitudinal faces as conditions require. A new cut is made only every three days.

Aluminum cups are used for collection of gum with wood covers to keep out chips and leaves.

The first tapping of second growth trees usually commences in about eight years when there are approximately 700 trees per hectare, selecting trees of about 7 inches diameter. After this, a combination of tapping and thinning is carried out. Every three years, certain trees are selected for thinning and are tapped to death in about three years before cutting. In the meantime, the remaining sturdier trees are tapped less severely so as to maintain their growth, usually starting with one face, and after three years, changing to the opposite side with a new face to allow the old face wound to gradually close. When the diameter of the tree has reached 12 inches, two faces together are usually employed instead of one.

**Used as Producers for Many Years:** — The thinning, tapping, and selecting continues until probably only 100 healthy trees per hectare remain. These are used as producers for many years until, based on the economic calculations of yield values, it may be found better to cut the area and replant. How long this cycle will be, it is too early yet to determine.

The method of thinning and degree of same will depend upon the relative value of product for gum compared to pulpwood which it will be possible to calculate from the records of yields, growth, and costs.

If a high production of gum is desired, a more rapid thinning by overtapping will be maintained to increase the yield of the producing trees.

If pulpwood is found to be the more valuable product, the thinning will not be so intense, leaving the cutting for pulpwood to the thinning.

In the future, perhaps some selective cutting

may be exercised to provide cheap lumber. However, there are many other native woods more generally used for this purpose.

**Labor:** — The enormous amount of work required in building roads through this mountainous area, planting, collecting, and transporting the products, is economical mainly on account of the cheap coolie labor available, mostly imported from Java.

The Netherlands Indies island possessions as a whole have a population of 70 millions. Java with only 5% of the total area has 70% of the population, approximately 50 million, of which 600,000 are Chinese and 200,000 Europeans. Sumatra, three times the area of Java, has a population of only 8 million, of which 50,000 are Europeans.

**Does Not as Readily Work for Wages:** — Generally speaking, the Sumatran, be he Malay, Achinese, Batak, or Menangkabo, does not as readily work for wages, and Chinese and Javanese farmers are moving from overpopulated Java to settle in Sumatra and work as coolies securing good wages (in respect to their needs), lodging, and hygienic supervision for themselves and their families. At Lake Takengon, the government maintains for instance a modern well-equipped hospital for the native workers on the plantations referred to in this article.

In Java, to feed the rather heavy population, practically the whole usable territory is put under cultivation and under Dutch tutelage all resources have been brought to play including a marvelous and unique system of irrigation, canals, dams, and control works. One fifth of the island area is under cultivation for rice, the staple native diet. With the emigration of many to the adjoining island of Sumatra, the same excellent government supervision is beginning to take shape there also.

With no exploitation of native labor and government assurance of the rice crop and its cost, hygienic and educational facilities, the Malayan is generally a contented, smiling worker, and also shows considerable aptitude in entering the ranks of skilled labor as machinists, operators, clerks, etc., as, for instance, the main railways in Java are operated almost exclusively by them.

The average cost for coolie labor in the government naval stores operations is approximately 40 cents per 9-hour day, including wages, housing, hospitals, and other welfare provisions.

**Supervision:** — At the head of the Netherlands East Indies Government Plantations, with its main office in Batavia, Java, is H. VAN LENNEP, whose dynamic energy, indomitable spirit and perseverence, have worked marvels in this department, of which the naval stores operation is only a small one compared to rubber and other products. A forester at heart, with a high degree of technical knowledge, practical application and vision, coupled with a pleasing personality, he is never too tired to discuss the many plans he has for future utilization of the island's resources.

**Divided Into Areas of 6000 Acres:** — The naval stores forest operation and distillation plant are under the supervision of H. OOSTERLING as general manager, with headquarters at Lake Takengon, Sumatra, the center of the forest area which is divided into four or more districts of approximately 30,000 acres, each under a European district manager. These districts are again divided into areas of approximately 6000 acres, under a local European manager, with its complement of native labor, totalling some 3400 coolies from Java and 2000 local laborers for the whole area.

The site selected for the paper mill will be developed as a general industrial center for other products, byproducts, and chemical plants, many of which will be under the supervision of a nucleus of experienced American operators.

# RECENT STUDIES OF SEDIMENTS IN THE JAVA SEA AND THEIR SIGNIFICANCE IN RELATION TO STRATIGRAPHIC AND PETROLEUM GEOLOGY

*by*

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Petroleum will long continue to be an important source of revenue to the Netherlands East Indies. This mineral wealth is derived for the most part from late Tertiary formations that underlie much of East Sumatra, North Java, and East Borneo. The mother source of this petroleum was the organic detritus produced by plants and animals that inhabited a then greatly extended Java — or better Sunda Sea. An important constituent of these marine sediments are the calcareous shells of *Foraminifera* that range in size from a mere speck to more than a centimeter in diameter. The repeated subsidence and elevation of the floor of this ancient sea caused modifications in local ecological conditions that were reflected in the species of *Foraminifera* that inhabited the region, and with the passage of time, new species were introduced while others became extinct. For these reasons each zone in a stratified geological formation contains a more or less distinct assemblage of species.

In the search for petroleum, oil seepage or escaping gas are valuable clews, but do not necessarily suggest that oil in commercial quantities remain in the structure. Something of the geological history of a region may be determined

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."* — Dr. MYERS worked in the Laboratory for Marine Biology in Batavia, from 1939 till 1941. He plans to return to Java to complete his researches on the *Foraminifera* as soon as circumstances will permit.

from samples removed from exposures such as cliffs, excavations or wells. The location of probable oil traps such as anticlines or domes and fault lines are established through the study of topographical charts, air reconnaissance, or where these fail, subsurface structures may be recognized through the recording and interpretation of local seismic disturbances set up by the discharge of high explosives.

When a favourable site is located and drilling operations are under way, samples of the strata through which the drill passes are removed at frequent intervals and these are sent to a paleontological laboratory for study. At the laboratory the sample is given a number and a careful description of its characteristics made. A portion of the sample is then reduced by grinding and washing away the finer sediments. It is then dried and the *Foraminifera* removed under a microscope with the aid of a small brush. The *Foraminifera* are then mounted on slides and the individual species as well as the total assemblage studied and compared with the species observed in previously obtained samples. Certain species are then selected as guide fossils for that particular strata, and the assemblage is represented on a chart by means of a special type of marking. From subsequent samples the total thickness of the strata as well as that of succeeding strata are also charted. When a producing zone has been located beneath a recognized series of strata and a similar sequence of strata are encountered in a new well, the driller knows that the drill is penetrating favourable formations, but should these strata fail to appear before deeper structures are encountered, he knows that the producing zone does not extend to the new location.

When the sequence of strata have been determined in several wells they are charted by means of an electric logging device, and when these logs are compared with that of newly drilled wells, correlations may be attempted and these substantiated through the microscopic examination of a minimum number of samples.

Marine sediments underlie approximately 70% of all land areas and although petroleum has had its origin in these sediments, areas in which producing fields have been developed are limited. Therefore it is important that we discover, if possible, those types of sediments which have given rise to petroleum in commercial quantities and be able to trace these and the related strata that conduct the oil to porous formations that serve as traps. The way in which the *Foraminifera* are used in tracing geological formations has been discussed. Since the ecological conditions that prevailed at the time the source rock was deposited no doubt influenced the types of *Foraminifera* that inhabited the region, the shells should also be useful as guides to these particular sediments. In making correlations it is useful to know the age of the formations involved and again the *Foraminifera* serve as guides. The designation of species is often complicated by the fact that several types of shells may be produced by a single species and relationships can only be determined through the study of life cycles in the laboratory. Geological species existed no doubt under conditions similar to those now prevailing in the sea and we cannot hope to fully appreciate the value of the *Foraminifera* as guide fossils until we know more concerning those factors which limit the geographic and bathymetric distribution of existing species.

The relationship between the ancient nearly land-locked Sunda Sea, whose sediments are the present source of much petroleum, and the Java Sea made this region seem particularly favorable for the study of the *Foraminifera* in relation to ecological conditions and to correlate these data with the observations of petroleum geologists.

The Java Sea is rectangular in shape, being some 500 miles long and 200 miles wide. The mean depth is less than 30 meters except for the channel of an ancient river that extends for 100 miles from north of the Island of Bawean to the east where it breaks through a sunken barrier reef that once marked the eastern limit of the region before it was inundated by the sea.

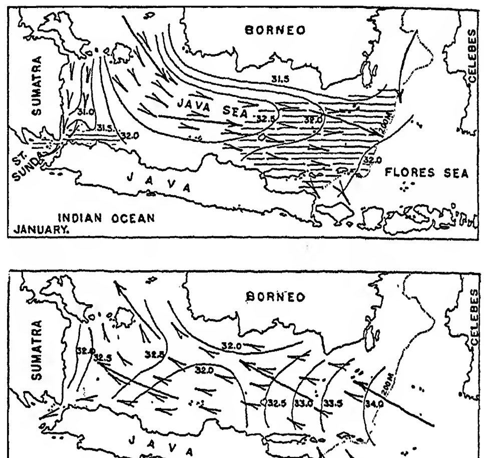
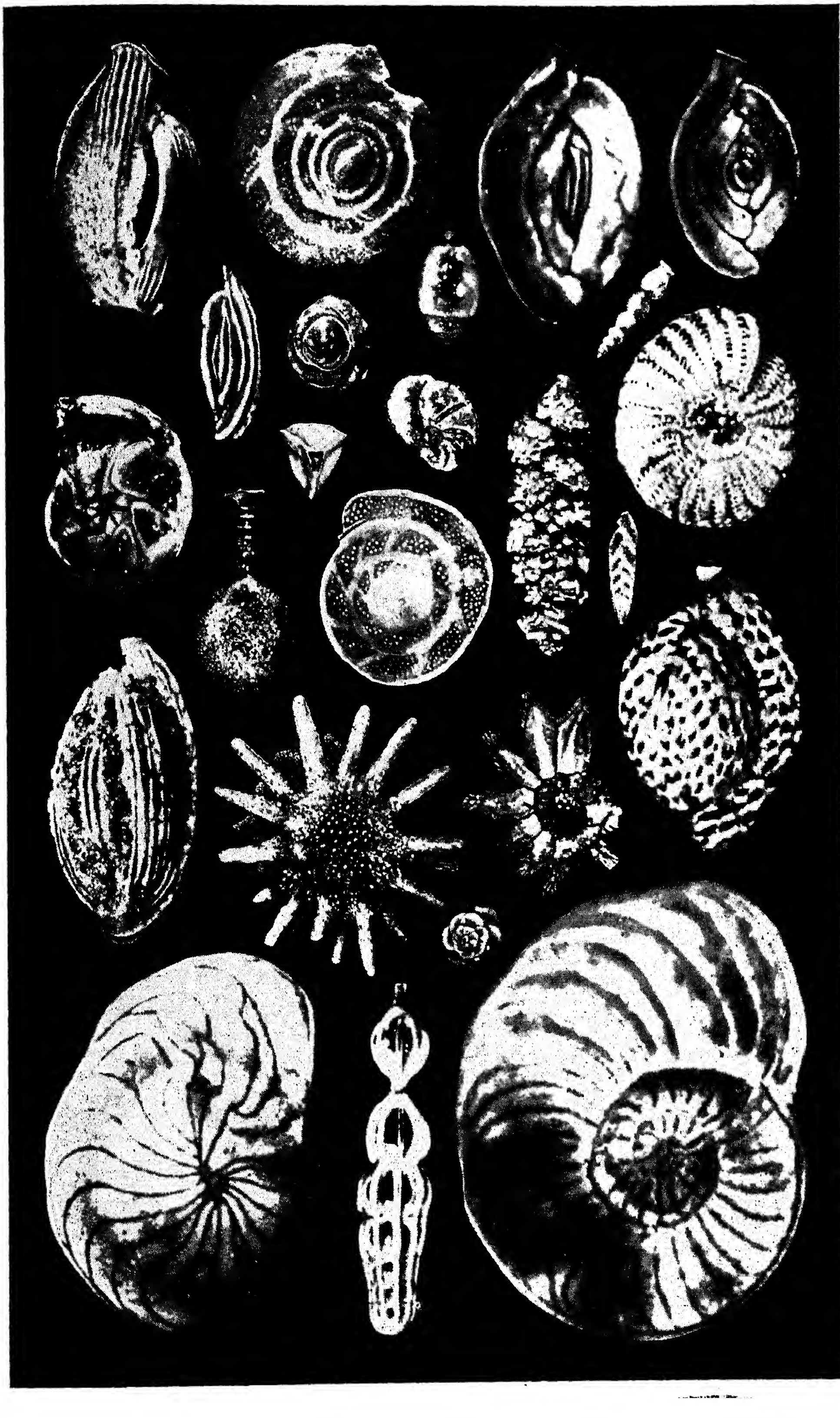



FIGURE 73. — PROBABLE COURSE OF ISOHALINES IN THE JAVA SEA. — Darts indicate currents, and arrows wind direction.

The temperature of the water throughout the year is 27° C. ± 1° C. and does not vary by more than 0.5° C. between the surface and the bottom at 40 meters. The West Monsoons prevail from December to April during which water from the shallow South China Sea displaces that of the

FIGURE 74. — FORAMINIFERA, THE SO-CALLED "OIL BUGS" OF THE PETROLEUM INDUSTRY. — The *Foraminifera* of the Java Sea range in size from that of a mere speck of dust to more than a centimeter in diameter. They assume an amazing var ety of forms, and the walls are either chalk-like, porcelaneous, glassy, or composed of minute grains of sand or other materials. Many species found in the vicinity of coral reefs are beautifully colored when viewed by direct illumination.



Java Sea. This exchange of water is reversed during the East Monsoons which blow from April to December when the water of the Java Sea is displaced by water from the deeper Flores Sea. Wind induced turbulence does not disturb the bottom sediments at depths of more than a few meters since winds of gale velocity are unusual and of short duration. The mean salinity of the water is about 33 parts per thousand or slightly lower than that of the great oceans and does not vary by more than 1.3 parts per thousand except where large rivers enter the sea. It is not unusual to be able to see a small white disc (the Secci disk) at depths of from 30 to 40 meters, and the clearness of the water together with the proximity of the Java Sea to the equator (3°–7° South Latitude) permits sufficient light penetration for plants to thrive at all depths, but for the most part these plants are microscopic in size since the soft bottom muds and shifting sands do not provide a suitable attachment for larger algae. The major portion of the nutrient salt content of the water is locked at all times in the bodies of these micro-plants and the animals that eat them, and as a result the amount of food available to fish is so limited that schools of migrating fish seldom enter the sea nor do the larger sharks that depend upon these schooling fish for food. Further, fish-eating birds are limited for the most part to those that feed in shallow lagoons and the gulls of higher latitudes are replaced by kites.

Coral reefs are restricted to the shallow waters bordering the scattered islands that lie to the north of Java, the eastern margin of the sea and along the shores bordering the straits that enter into the Indian Ocean. The beauty and magnitude of these reefs is somewhat amazing when one recalls the limited amount of food organisms produced by the nutrient salt impoverished waters of this shallow sea. The shores of East Sumatra, South Borneo and North Java, are for the most part low mud flats, bordered by mangrove swamps and although the total salinity near the coast is depressed by the numerous rivers that empty into the sea, this fresh water, rich in nutrient salts, contributes materially to the support of marine life in the coastal waters.

A line extending from east to west through the Java Sea roughly divides the bottom sediments of the region into two distinct groups. Those to the north are largely derived from the non-igneous formations of Borneo, while those to the south were derived from the volcanic rocks of Java. Coarse quartz sand is found in the vicinity of the several entrances to the sea, but the great central basin is for the most part composed of soft muds that are rich in calcium carbonate in the vicinity of coral reefs.

In this investigation samples of bottom sediments were taken at intervals of about 50 miles throughout the area and on the reefs bordering all important groups of islands. These samples were obtained with the aid of a coring device that consisted of a weighted tube provided with a valve to retain the sediments and a special device that removed a unit area of surface sediments from which the abundance of living *Foraminifera* could be determined. A light dredge for recovering large numbers of living *Foraminifera* was also used. Ecological data taken included secchi disc readings, temperatures, current direction, and velocity and water samples for total salinity and other determinations.

It was found that at these shallow depths each type of bottom produces a distinct population of *Foraminifera*. In the lagoons and platforms back of reef areas only those species survive that are adapted to the habitat provided by densely growing fronds of seaweed or are rigidly attached to dead coral since the scouring action of the surf makes less protected surfaces untenable. In the zone of living corals below low tide level, living *Foraminifera* do not occur unless they are associated with weed or dead corals. On a sandy mud bottom, immediately adjacent to reef areas there is a closely related but nearly totally different population. This group includes larger species which for the most part lack the brilliant colors of those living at shallower depths. However, as might be expected, the sediments of this zone contain the empty tests of species found in both habitats. On heavy mud bottoms one finds larger species similar in size to those living on a sandy mud bottom, but the tests are usually more flattened or otherwise adapted to glide over these softer sediments. Far from land the mud is little more than a water suspension, and only the smallest of *Foraminifera* survive since larger species or those not especially adapted to this substratum would sink below the surface muds and starve. A bottom composed of coarse quartz sand suggests heavy sorting by current action and although the tests of *Foraminifera* may be numerous, the majority of living individuals are those having a relatively brief life span, and a small test.

The tests of many species of *Foraminifera* as has been suggested show characteristics that adapt them to a particular habitat. Species living on weed in quiet water are often provided with numerous heavy spines that protrude in all directions. Related or other species provided with spines that extend in one plane only, spend at least the latter part of their existence moving about over a firm usually sandy mud bottom. Exceedingly long attenuated spines in one plane are produced by species living on soft mud bottoms while species that have delicate spines that extend in all directions, and chambers that are globular in shape are free floating or pelagic. Tests having a large, thin, discoidal shape and showing evidence of having conformed to the contour of the surface upon which they developed are also found living on weeds or grass. Large tests in which the chambers are spirally arranged and much flattened are numerous on firm mud bottoms while tests having a much thickened central area are found on firmer sandy mud bottoms. Those provided with a thick lens-shaped test are common between the protecting fronds of algae, and are also numerous on heavy mud bottoms. Minute species without spines and irrespective of shape are to be found in all habitats and the apparent range is usually greatly extended by turbulence and current action. Pelagic species succeed only in deep water and do not survive for long in a shallow sea. For this reason it is possible to trace the direction and estimate to some extent the relative amount of water entering the Java Sea from the Indian Ocean through the several straits from the number of shells of these species observed in the sediments.

Where temperature, salinity, depth, oxygen tension, nutrient salt content of the water and other conditions are relatively uniform and where there are no barriers to distribution as is the case in the Java Sea, one would expect only slight dif-

ferences in the species that populate the region. This is for the most part true of the foraminiferal fauna, however, it is also true that the nature of the substratum definitely limits the distribution of most if not all species.

From these studies it becomes evident that the smaller, more widely distributed *Foraminifera* are most useful in recognizing a geological horizon; that larger species suggest a particular type of habitat and because of their more obvious characteristics are useful in determining the age of a formation. That the presence of numerous tests of pelagic species suggests the proximity of deep, typically oceanic conditions while a predominance of other forms is typical of the shallower waters of a continental shelf or shallow sea, and that where heavily spined forms are common, the climate was tropical or sub-tropical, and when abundant that they were produced in protected bays or in seas where storms were of infrequent occurrence. Species typical of the deeper portion of the continental shelf were uncommon or absent in bottom samples from the Java Sea even at depths in excess of 200 meters near the outer margin of the Sunda shelf. Brief periods of turbulence cause many *Foraminifera* to become buried to depths from which they cannot escape. Under certain recognizable conditions, bacterial decomposition of the contained protoplasm cause the tests to become filled with iron sulfide, while other conditions cause them to fill with a greyish clay that develops into a greenish mineral known as glauconite when conditions are suitable.

In any attempt to reconstruct a geological horizon, paleontologists employ not only the *Foraminifera*, but the fossil remains of all plants and animals recovered and the mechanical and chemical characteristics of the samples provide further information concerning the physical and chemical conditions in the water as well as the nature of and distance to adjacent land masses.

In the Netherlands East Indies, Dr. F. A. V. BARREN recently made a thorough study of the sediments of the Java Sea. The distribution of coral reefs, both recent and geological were studied by Dr. VAN DER STOK. Dr. VAN WIEL has investigated the chemical and physical conditions in the waters of the Java Sea, and these investigations were being extended under the direction of Dr. J. D. F. HARDENBERG, with the aid of the members of the staff of the Bureau of Sea Fisheries. Numerous taxonomic and ecological studies have been made of the fauna and flora of the Java Sea and it is to be hoped that these studies will soon be resumed, since in this region it is possible to virtually eliminate from many problems any serious consideration of certain ecological conditions that are usually considered of primary importance in discussing the bathymetric and geographic distribution of marine plants and animals. This work on the Biology of the *Foraminifera* of the Java Sea was financed through the Guggenheim Memorial Foundation, and later a Rhumphius Fellowship granted by the Treub Laboratory at Buitenzorg. The completed report is being reserved to be published in the Netherlands East Indies, although certain phases have, and will continue to be discussed in current papers.

# RABIES RESEARCH

# IN

# THE NETHERLANDS INDIES

*by* the late MARIA J. OTTEN-VAN STOCKUM, M.D.

(† May 26, 1940) *

*late Assistant, Pasteur Institute, Bandoeng, Java*

*with a foreword by* DR. I. SNAPPER

*The author of this article died on May 26, 1940, one year before the publication of this study. In an introduction to this article the author's husband, Dr. L. OTTEN, writes that as the results of the author in various directions were only partly recorded, it was impossible to give a full account of the researches performed by the author. Therefore, even the article as originally published in the Mededeelin-*

* Reprinted from the author's "Rabies Researches," A Contribution from the Pasteur Institute, Bandoeng, Java, *in Meded. van den Dienst der Volksgezondheid in Nederlandsch Indië* 30:109 seq. (1941).

*gen van den Dienst der Volksgezondheid in Nederlandsch-Indië comprised only two of the almost finished chapters of her work.*

*Here, we reproduce solely the first chapter. This part contains the discussion of the outstanding results obtained by the author with her new method of immunization against hydrophobia, together with the discussion of the statistical method she used to gauge the results of this vaccination. It is remarkable how unfavorable the results of other Rabies Institutes are proved to be if tested with her apparently sound statistical method and how excellent the results of the author appear.*

*Of the chapter reproduced here, there existed only drafts in English and French intended as a résumé to the author's monograph published in 1935, entitled "New Principles of Anti-Rabic Treatment and Rabies Statistics." As the majority of readers would have been unfamiliar with the monograph, this chapter without further explanation would not have been clear in view of the intricate nature of the subject. In preparing the article for publication, therefore, Dr.* L. OTTEN *added such information as made the matter more self-explanatory while adhering to the spirit of the author. The results of the rabies treatment obtained in the year after the author's death have been included in the relative tables.*

*The original article contained a second chapter covering the experimental work of the author and an extensive criticism of M. C.* KENDRICK'*s Ninth Statistical Review of the rabies work as published in 1940. Interesting as these two chapters are, they have not been reproduced here.*

*Dr.* OTTEN *terminates his introduction with the following remarks: "It was many years before she (the author) saw the correctness of her new method of analysis which is as original in conception as it is simple in practice, confirmed by animal experiment. This experience should serve as a serious admonition to many who, after only a short term of experimental work on such an extremely difficult subject as rabies, may be called on to publish their results."*

*We want to add that the lack of interest for the author's method of immunization, which until now has characterized the attitude of other Rabies Institutes, must be considered unfortunate. The data published here deserve careful consideration, especially in view of the unfavorable results of rabies vaccination in other parts of the Orient.*

* * *

**I. Results of antirabic treatment with live and formalized monkey fixed virus in the light of a new method of analysis of rabies statistics:** — It is now more than 50 years since PASTEUR succeeded in transforming a street virus strain into a fixed virus and thus opened wide prospects for the possibilities of anti-rabic treatment in man. The enthusiasm with which the quinquagenary of this discovery was celebrated will have been somewhat tempered for those who realized that posterity has failed in the task set by the great Leader in the combat against rabies. The results, which on the whole have been rather disappointing, should have been reason for humility rather than excessive rejoicing by those assembled to do homage to the memory of PASTEUR, a memory too often wronged by the tendency to obscure shortcomings in treatment by overpraise of successes.

This common tendency, naturally, constitutes a serious obstacle to progress and, as a consequence, it is an established fact that the development of anti-rabic treatment has not advanced beyond its initial stage and the high expectations that it fostered on its introduction have not been realized.

Supported, however, by steadfast confidence in the legacy of PASTEUR and the unshakable conviction that the way to success is being barred only by factors of minor importance, the time has now come when the facts must be faced and no longer ignored by tacit agreement. However ardently and stubbornly illusions may be cherished the truth finally must come to light and then the danger is not imaginary that opinion goes too far and PASTEUR's discovery may be under-rated, however undeserved.

Demolition, however, is the first step to reconstruction: the method of anti-rabic treatment as well as the statistical evaluation of its results both demand a thorough revision regardless of personal or national feelings, so often masked by hero-worship. Once more, therefore, I must draw attention to the striking results which, since 1916, have been regularly obtained with the treatment in this country.

The principal points which were dealt with in my Monograph of 1935 may be again stated here and briefly recapitulated below:

*a. The mortality rate of hydrophobia during and after treatment cannot form a reliable basis for exact evaluation of results in the treatment of man.*

*b. The division of cases of hydrophobia according to the incubation period, irrespective of the number treated, forms a sound statistical basis for the evaluation of results.*

*c. The results obtained by the application of this statistical method compel acknowledgement of the fact that, hitherto, anti-rabic treatment has almost entirely failed.*

*d. Experience in the Netherlands East Indies has proved that the nature of the antigen, viz: the species of animal providing the fixed virus, is of decisive significance, and that vaccine prepared from monkey brain is the best antigen for the treatment of man.*

*a.* In spite of the fact that it has long been known that mortality rates among treated constitute entirely unreliable criteria, rabies workers, up to the present, persist in the adherence to this mortality as a standard for the effect of treatment. Moreover, there is an increasing tendency to depart from the policy formulated by PASTEUR, who attached great importance to the incidence of hydrophobia in relation to the period between the bite and the commencement of treatment and in relation to the number of days after the commencement of treatment. A sharp distinction was made between the mortality in the first 28 days after the commencement of treatment and the later so-called reduced mortality. PASTEUR, thus, appreciated the fact that immunization proceeds only slowly and, accordingly, he estimated that full immunity was first attainable 14 days after the end of treatment. Where originally this occupied 10–14 days, all cases with a short incubation period, *i.e.* within the first 4 weeks, were thus past help, so that only cases appearing later than 28 days after the commencement of treatment had to be regarded as failures of treatment [1]. At present, however, most investigators are content to give merely the mortality rates among treated without regard for these

[1] In later years the period of treatment has often been extended. Regardless of the duration of this, however, the period of 14 days after the end of treatment has been adhered to as the "failure limit," thus making it possible by prolonged treatment to obscure a number of failures.

principles. Thus all data for comparable statistics are withheld or lost.

But also, apart from this omission, the mortality rate can never furnish a basis for comparison, entirely misleading as it is. Indeed, a large proportion, as a rule the majority of people who receive treatment, have never been infected. This explains why, irrespective of the method of treatment, the mortality rate is generally very low and out of all proportion to the rate — however difficult this may be to estimate — among those in whom the risk of infection was real. It is obvious that in this way the success of treatment will be overestimated, the more as the risk of infection decreases. This is the very reason why mortality as a basis of comparison is so stubbornly adhered to and why every effort to explode this fallacy meets determined passive resistance.

*b.* My proposal to omit the *number treated* is intended to eliminate the majority of incidental factors which cause so many divergencies in the usual data. By confining oneself to only *cases of hydrophobia* which occur during and after treatment and dividing these according to the incubation period, having regard, of course, for the period between the bite and the commencement of treatment, a sound statistical basis is provided for comparison of various methods of treatment, as may be seen from Tables I—III below.

Accordingly, the following 3 groups of cases must be distinguished:

1. Cases occurring *within 30 days of the bite.*
2. Cases occurring *later than 30 days after the bite.*
3. Cases included in group 2 in which hydrophobia appears *later than 30 days after the commencement of treatment—that is the failures.*

The first group represents cases with a short incubation period, the second those with a longer one, and the third group embraces the failures as a part of group 2. This division is thus entirely in line with the principles of PASTEUR, only the especially for the evaluation of results in late and early treatment. Exclusive adherence to the reduced mortality leads to inaccurate and even paradoxical conclusions in proportion to the degree of activity of the method of treatment applied (see Monograph pp. 26—28).

*c.* That the original Pasteur-method of treatment with rabbit cord fixed virus attenuated by drying, everywhere, irrespective of time and place, gives the same unfavourable results, is clearly illustrated by Table I.

These figures relate only to cases where treatment was started in the first week. It appears that, notwithstanding the great variation in the mortality rates, the division according to the incubation period is almost everywhere the same and particularly, the proportion of failures is very large. This even is lowest for the Netherlands East Indies, in spite of the highest mortality rate. If, however, one confines oneself to wounds of the limbs in which, as a rule, the incubation period is longer and thus a high failure rate is a still stronger plea against the effects of treatment, the whole difference disappears.

The "dried cord" method was, in many places, for example in British India, replaced later by carbolized vaccine (rabbit brain and cord) according to the method of SEMPLE. It will appear from Table II, which is compiled from data on treatment in the first week extracted from the Annual Reports of the Kasauli Institute, that, notwithstanding increasingly higher dosages, this method did not give more favourable results and also that the substitution of rabbit fixed virus by that of sheep did not give a definite improvement either.

The methods of both PASTEUR and SEMPLE disclose, by their constant and terribly high number of failures, especially in wounds of the limbs, that they are entirely inefficacious. This, possibly, becomes clearer from a study of the following table in which data of the incubation period in

TABLE I. *Treatment with the* Pasteur-*method all cases of hydrophobia treated in the 1st week.*

| Institute | | Totals | % death rate | Within 30 days of bite | % | > 30 days of bite | % | Failures | % |
|---|---|---|---|---|---|---|---|---|---|
| Paris | 1886—1887 | 29 | ? | 6 | 21.– | 23 | 79.– | 21 | 72.– |
| | 1914—1924 | 32 | 0.32 | 10 | 31.– | 22 | 69.– | 21 | 65.5 |
| Berlin | 1898—1917 | 34 | 0.71 | 8 | 23.5 | 26 | 77.5 | 25 | 74.– |
| Vienna | 1894—1921 | 163 | 1.27 | ? | ? | ? | ? | 107 | 64.– |
| Neth. East Indies | 1895—1905 | 65 | 4.68 | 30 | 46.– | 35 | 54.– | 31 | 48.– |
| *Cases of hydrophobia with wounds of the limbs only.* | | | | | | | | | |
| Paris | 1886—1887 | 20 | | 3 | 15.– | 17 | 85.– | 15 | 75.– |
| | 1914—1924 | 17 | | 2 | 12.– | 15 | 88.– | 14 | 82.– |
| Neth. East Indies | 1895—1905 | 36 | | 6 | 17.– | 30 | 83.– | 27 | 75.– |

period in which immunity is attained, for simplicity, being taken as 1 month (30 days) instead of 4 weeks. Whereas, however, PASTEUR distinguished these groups in connection with the number treated and estimated the results according to mortality, in particular according to the reduced mortality, I consider the mutual numerical ratio, regardless of the number treated, as essential. This division according to the incubation period is even indispensable for a comparison of the treated and untreated cases and *untreated* cases of hydrophobia are given. These cases were observed in France during the years 1862-1872, while BAUER'S figures (1886) are extracted from the German and Austrian literature. The data from both sources, therefore, refer to the years preceding PASTEUR'S discovery and they present entirely the same picture: about 20% of the cases occur in the first month, 80% during the following months (for wounds of the limbs alone these percentages are 10% and 90% respectively).

When the division of these cases according to the incubation period is compared with that in Tables I and II, the proportion of the number of cases appearing within and after the first month after the bite in the untreated appears to be nearly the same as after treatment with one of the methods mentioned. This alarming conformity in the incubation period of cases of hydrophobia with and without treatment indicates how much these methods fall short in effectiveness.

That with these methods of treatment the percentage of cases after the 1st month is 10—20% lower than the 80% which fell in that period before the application of anti-rabic treatment, is explained by the fact that those bitten do not all come for treatment with equal promptness and some do not even come at all. The more serious the wound the more quickly, *ceteris paribus*, will the bitten people, as a rule, obtain treatment; the slighter the wound the greater the delay. Thus, the group treated in the first week comprises proportionately more seriously wounded, so that the chance of the outbreak of hydrophobia after short incubation periods is greater. The mortality in this group in the first month will, therefore, exceed 1/5 of the total; in other words, in the later months it must always be below 80%, which applies also to the failures.

TABLE II. *Treatment with the method of* Semple (*Kasauli*) *all cases of hydrophobia* (*treated in the 1st week*).

| Period | Totals | % death rate | Within 30 days of bite | % | > 30 days of bite | % | Failures | % |
|---|---|---|---|---|---|---|---|---|
| 1915—1919 | 207 | 1.3 | 57 | 27.5 | 150 | 72.5 | 136 | 65.7 |
| 1929 | 88 | 2.1 | 23 | 26.- | 65 | 74.- | 60 | 68.2 |
| 1930 (sheep) | 82 | 1.6 | 27 | 33.- | 55 | 67.- | 47 | 57.3 |
| *Cases of hydrophobia with wounds of the limbs only.* | | | | | | | | |
| 1915—1919 | 131 | | 16 | 12.- | 115 | 88.- | 106 | 81.- |
| 1929 | 53 | | 10 | 20.- | 43 | 80.- | 43 | 81.- |
| 1940 (sheep) | 50 | | 10 | 20.- | 40 | 80.- | 34 | 68.- |

TABLE III. *Cases of hydrophobia in untreated* (*before* 1886)

| | Totals | Incubation period | | | |
|---|---|---|---|---|---|
| | | Within 30 days | % | > 30 days | % |
| French Commission | 170 | 38 | 22.5 | 132 | 77.5 |
| Bauer | 423 | 91 | 21.5 | 332 | 78.5 |
| Bauer (limbs) | 166 | 17 | 10.- | 149 | 90.- |

It has already been remarked that a portion of those bitten do not come for treatment at all, this proportion increasing as the severity of the wounds decreases. Thus the inevitable result of anti-rabic treatment becoming available in a given territory will be that a divergence occurs in the normal course of the frequency-curve of the incubation periods in cases of hydrophobia among treated and untreated. In the first group, especially among those treated in the first week, more than 1/5 of the cases will occur in the first month. In the group of untreated, however, which for the greater part will comprise those less severely wounded and therefore, as a rule, include cases with a longer incubation period, the mortality in the first month will be less than 1/5 of the total mortality. For this reason a comparison between treated and untreated becomes impossible as soon as an institution for anti-rabic treatment is established.

For a more extensive discussion of this inverse selection among treated and untreated and the influence of this on the curve of the incubation period in cases of hydrophobia in both groups, reference may be made to my Monograph, p. 44, where the statistical work of Nitsch (1906) was analysed. Nitsch, who clearly distinguished this deviation in the rabies material from Galacia (Krakow), believed that he saw in this, especially in the reduction of cases with a long incubation period in treated, a proof of the efficacy of this treatment (Pasteur-method) despite the high percentage of failures. In this, however, Nitsch erroneously assumed that both groups would be comparable, an error which even now is still being made, as may be seen in a recent publication of Dodero (1938). This is the more remarkable since the contents of my Monograph must have been known to this author as he has taken over the data collected by me relating to the incubation periods in the untreated, though without acknowledgement of the source.

*d.* The anti-rabic treatment in the Netherlands East Indies, which was commenced in the year 1895 with fixed virus strain Paris, has been frequently changed in the course of the years. From 1895 to 1905 the Pasteur method was applied, first according to the original scheme and later with reinforced dosages. This gave place in 1906 to the Högyes dilution method with unattenuated fixed virus prepared from rabbit brain. In the middle of 1916 this virus was substituted by that of monkey (1st passage) with the object of thus being able to prepare greater quantities of vaccine; the average brain of our rabbits weighs only 8 grammes against 60 for that of the monkey. The choice of this antigen [1] was quite fortuitous; an experimental basis was lacking nor had theoretical considerations pointed that way. After a few attempts, with little success, with carbolized vaccine a first experiment was made in 1930 with formalized vaccine, which gradually replaced the live virus and is now used exclusively. In Table IV the results for the successive periods to the end of 1940 for treatment in the first week, are set out:

[1] The *Mac. cynomolgus*, which is common here, is used; as shown from the results of various animal experiments, the *Mac. rhesus* gives an equally active vaccine.

TABLE IV. *All cases of hydrophobia in the Neth. East Indies (treated in the 1 st week).*

| Method of treatment | Totals | Within 30 days of bite | % | > 30 days of bite | % | Failures | % |
|---|---|---|---|---|---|---|---|
| 1895—1905: rabbit dried cord, attenuated | 65 | 30 | 46.– | 35 | 54.– | 31 | 48.– |
| 1906—mid. 1916: rabbit brain, live | 92 | 53 | 57.6 | 39 | 42.2 | 28 | 30.– |
| mid. 1916—1940: monkey brain, live, afterwards killed (formalin) | 50 | 48 | 96.– | 2 | 4.– | 0 | 0.– |
| *Cases of hydrophobia with wounds of the limbs only.* | | | | | | | |
| 1895—1905: rabbit dried cord, attenuated | 36 | 6 | 16.6 | 30 | 83.4 | 27 | 75.– |
| 1906—mid. 1916: rabbit brain, live | 50 | 21 | 42.– | 29 | 58.– | 23 | 46.– |
| mid. 1916—1940: monkey brain live, afterwards killed (formalin) | 20 | 18 | 90.– | 2 | 10.– | 0 | 0.– |

These figures give a striking illustration of the favourable turn after the change to monkey brain virus. The fact that by a moderate dosage, *viz.* 400 mgm. of live, c.q. 1520 mgm. formalized monkey brain vaccine — contrary to the enormous dosages of carbolized vaccine of rabbit or sheep brain in British India (up to 8 gm.) — practically all cases with an incubation period of more than a month disappear at one stroke, leads undeniably to the conclusion that this difference in results can be attributed only to the difference in the antigen.

It must be emphasized that the fact that, in this country, the number treated, and with it the number of cases of hydrophobia, is relatively small, in no way detracts from this conclusion. This remark may seem superfluous though in reality such is not the case, the tendency generally being to grant statistical significance to a difference only when supported by numerous observations. Though to a certain extent this is correct, the *quality* of the observations also plays a part and this applies especially to cases of hydrophobia analysed in the manner indicated. However small rabies statistics may be, 10 cases arranged according to the incubation periods, will amply suffice to estimate the method of treatment at its correct value.

That a great number of cases of hydrophobia, to which appeal is so readily made to minimize or completely ignore the value of small statistics, is by no means of conclusive significance is well illustrated by the high figures of the Kasauli Institute. If all of these cases, treated in the first week after the bite, are arranged in groups of 10 in their consecutive order of arrival and classified according to the incubation period, it will appear that in all of these groups the failure rate fluctuates between high limits, while the percentage of cases in the first month always remains low. Thus in the year 1929, out of a total of 87 cases treated with carbolized rabbit vaccine the failures were 64%, in the chronological order of the groups of 10 fluctuating between 40% and 90%, while the number of cases in the first month reached, at the highest, 40%. In the year 1930, the results with carbolized sheep vaccine were only slightly more favourable: the failure rate, averaging 59%, varied between 40% and 70%, while the number of cases in the first month did not reach more than 50% and, even then, in only one group. For cases with wounds of the limbs only the results were still worse and the differences still smaller: in 1929 the average number of failures was 73%, fluctuating between 60% and 90%; in 1930 the average was 67%, fluctuating between 60 — 80%. Table V clearly illustrates this.

If a similar grouping in chronological order is now made for the Netherlands Indies cases, the years 1895—1910 give the same picture. It is true that the number of failures is less and fluctuates between lower limits, *viz:* 48% (30—60%), but for cases with wounds of the limbs it shows the same level and the same fluctuations as in British India, *viz:* 71% (60—80%). A distinct decline first begins with the application of the reinforced HÖGYES method after which the failures are 19% for all cases and 30% for cases with wounds of the limbs only. It must, however, not be overlooked that this improvement was attained at the cost of an important increase in the amount of fixed virus infections from which several fatal cases of paralysis resulted. The difference, however, becomes more striking with the change over from rabbit to monkey fixed virus, first as live and then as formalized vaccine; since monkey brain has been used there has not been a single failure among those treated in the first week.

Just as the successive groups of 10 cases of the Kasauli Institute in British India as well as those of the earlier periods at the Pasteur Institute in Netherlands East India separately testify to the inefficacy of the treatment, so the 20 cases recorded in this country during 1916—1940, treated with monkey fixed virus, — all, except 2, occurring within the first month after the bite — are proof of the fact that the sudden disappearance of all failures and of practically all cases with incubation periods of more than one month, cannot be attributed to any element of chance in grouping but must be considered due exclusively to the antigen used[1].

In view of these facts it follows that when, in 1922—'23, a trial was made with carbolized rabbit vaccine and there were soon 2 failures among a small number of treated and those only slightly wounded, this treatment was quickly stopped.

[1] It is self-evident that these fine results are to be relied upon only because, from information received periodically, it is certain that all the persons treated are still alive or, if not, that hydrophobia as cause of death was excluded. That this is indeed guaranteed by our information service, which periodically collects data up to a year after treatment, is fully described in my monograph (p. 14). In many countries, even in Europe, these health returns are far from complete and the possibility is by no means excluded that the already unsatisfactory results are, in reality, even worse.

As the possibility was not excluded that better results could be obtained with monkey fixed virus, an experiment according to the alternating system was later carried out (1925—'30) with live and with carbolized monkey brain vaccine. When, however, 2 failures out of 8 treated with this carbolized vaccine also were recorded — while among 8 treated with the live vaccine there was not a single failure — this experiment, too, had to be stopped.

TABLE V.

| Place and period | All cases of hydrophobia | | | | Cases of hydrophobia with wounds of the limbs only | | | |
|---|---|---|---|---|---|---|---|---|
| | totals | within 30 days of bite | > 30 days of bite | failures | totals | within 30 days of bite | > 30 days of bite | failures |
| Kasauli 1929 | 10 | 3 | 7 | 5 | 10 | 1 | 9 | 7 |
| | 10 | 4 | 6 | 4 | 10 | 2 | 8 | 7 |
| Carbolized vaccine | 10 | 2 | 8 | 7 | 10 | 4 | 6 | 6 |
| | 10 | 3 | 7 | 6 | 10 | 1 | 9 | 9 |
| (rabbit brain) | 10 | 1 | 9 | 9 | 10 | 3 | 7 | 7 |
| | 10 | 3 | 7 | 7 | 3 | 0 | 3 | 3 |
| | 10 | 2 | 8 | 8 | — | — | — | — |
| | 10 | 4 | 6 | 5 | — | — | — | — |
| | 7 | 2 | 5 | 5 | — | — | — | — |
| | | | | 64.3% | | | | 73.6% |
| Kasauli 1930 | 10 | 3 | 7 | 4 | 10 | 1 | 9 | 6 |
| | 10 | 3 | 7 | 7 | 10 | 4 | 6 | 6 |
| Carbolized vaccine | 10 | 3 | 7 | 7 | 10 | 1 | 9 | 7 |
| | 10 | 3 | 7 | 7 | 10 | 2 | 8 | 8 |
| (sheep brain) | 10 | 4 | 6 | 5 | 10 | 3 | 7 | 6 |
| | 10 | 3 | 7 | 6 | 2 | 0 | 2 | 2 |
| | 10 | 5 | 5 | 5 | — | — | — | — |
| | 10 | 2 | 8 | 7 | — | — | — | — |
| | 3 | 1 | 2 | 1 | — | — | — | — |
| | | | | 59.-% | | | | 67.3% |
| Neth. East Indies | 10 | 6 | 4 | 4 | 10 | 2 | 8 | 8 |
| 1895—1909 | 10 | 2 | 8 | 6 | 10 | 2 | 8 | 7 |
| | 10 | 4 | 6 | 6 | 10 | 1 | 9 | 8 |
| Pasteur method | 10 | 7 | 3 | 3 | 10 | 3 | 7 | 6 |
| (rabbit cord) | 10 | 4 | 6 | 5 | 10 | 3 | 7 | 7 |
| | 10 | 6 | 4 | 3 | 10 | 3 | 7 | 7 |
| and | 10 | 5 | 5 | 5 | — | — | — | — |
| | 10 | 2 | 8 | 5 | — | — | — | — |
| Högyes method | 10 | 4 | 6 | 5 | — | — | — | — |
| (rabbit brain) | 10 | 4 | 6 | 6 | — | — | — | — |
| | | | | 48.-% | | | | 71.6% |
| 1910—mid 1916 | 10 | 7 | 3 | 3 | 10 | 4 | 6 | 4 |
| | 10 | 5 | 5 | 2 | 10 | 7 | 3 | 2 |
| Högyes method | 10 | 7 | 3 | 2 | 6 | 2 | 4 | 2 |
| reinforced | 10 | 9 | 1 | 0 | — | — | — | — |
| (rabbit brain) | 10 | 5 | 5 | 4 | — | — | — | — |
| | 7 | 6 | 1 | 0 | — | — | — | — |
| | | | | 19.3% | | | | 30.8% |
| mid 1916—1940 | 10 | 9 | 1 | 0 | 10 | 9 | 1 | 0 |
| | 10 | 10 | 0 | 0 | 10 | 9 | 1 | 0 |
| Högyes method | 10 | 10 | 0 | 0 | — | — | — | — |
| and | 10 | 9 | 1 | 0 | — | — | — | — |
| formalized vaccine | 10 | 10 | 0 | 0 | — | — | — | — |
| (monkey brain) | | | | 0.-% | | | | 0.-% |

British Indian investigators consider that this was terminated too soon and so the carbolized vaccine was not given a proper trial. Bearing in mind, however, that during the years 1916—1930, with monkey vaccine treatment, not a single failure occurred out of 25 cases of hydrophobia, while with the carbolized vaccine, during the years 1922—1930, out of only 12 cases the failures were no fewer than 4, this reproach can hardly be justified. If these workers had better realized that a few early treated cases were sufficient to estimate the method at its real value, they would have saved themselves much time and trouble in checking the etherized vaccine. Apart from the fact that the data so far available could not pass muster which, of itself, was sufficient reason to reject such an unpromising experiment (*vide* Monograph pp. 84—106), a few months should have sufficed to justify complete abandonment of the method.

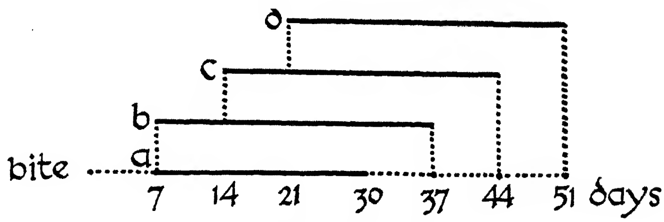
According to the data published by CUNNINGHAM and MALONE in 1930, after the introduction of the ALIVISATOS method, among the first 10 cases of hydrophobia no fewer than 7, and among the first 10 with wounds of the limbs even 8 failures occurred, and this notwithstanding that they were all severely wounded and so, in the majority, a short incubation period was to be expected. These first 10 cases occurred in the period 3 Dec. 1926 — 21 Ap. 1927, thus in scarcely 4 months

from the commencement of the experiment. Had full attention been paid to these unsatisfactory results — even though, admittedly, they were not so obvious in comparison with those with the usual carbolized vaccine — these investigators would certainly not have wasted their energies on this ungrateful task and not devoted a second Memoir (1933) to etherized vaccine, which gives as disappointing results in experiments as in the treatment of man. Moreover, SHORTT and his co-workers (1934) would not have needed 3 years to reach the conclusion that the etherized vaccine, so much extolled by ALIVISATOS and HEMPT and also recommended by REMLINGER, in no way deserves preference to SEMPLE'S carbolized vaccine.

Returning to monkey fixed virus, it appears from a comparison of the results of early (1st week) and later (2nd—4th weeks) treatment that cases with longer incubation periods certainly do occur and that only by early treatment they can be limited to the first month. This is also to be expected, as immunity develops at a late stage of the treatment and, moreover, where cases of hydrophobia with short incubation periods increasingly fall off, the percentage of cases with long incubation periods must increase in proportion to the delay in commencing treatment.

Although this matter was fully discussed in my Monograph, it may here be once more clearly illustrated by a graph. Herein, a hypothetical method of treatment is presumed which results in the slowly developing immunity reaching its peak 30 days after the commencement of treatment and which thereafter is able to prevent all cases of hydrophobia — and thus failures — irrespective of the time at which treatment is commenced. For simplicity it is also assumed that no cases occur (as indeed very seldom happens) in the first week and that treatment is commenced with 4 groups (a—d) of normal composition, immediately, 7, 14, and 21 days, respectively, after the bite (see Fig. 75).

The horizontal lines a, b, c and d thus represent the full range of the incubation periods in the cases which occur according to the moment on which treatment was started after the bite; later than 30, 37, 44 and 51 days, respectively, after the bite, therefore, no further cases should occur.




— FIGURE 75 (*see* p. 275) —

In practice, however, the commencement of treatment in these 4 groups will not be limited to the first day of each of the 1st to 4th weeks, but will continue on each day of the respective weeks, so that the maximum incubation period for each group will, therefore, extend to a further 6 days after the bite. The longest incubation period for such a hypothetical method will thus be calculated to correspond with the number of days as shown in Column 2 of Table VI, given above.

If the maximum incubation periods are now traced, as has been observed with treatment in the 1st—4th weeks since the use of monkey fixed virus (Col. 3) these, with the exception of 2 failures among those treated in the second week, fall perfectly within the limits as calculated in the manner specified. With treatment in the first week the longest incubation period is still 4 days below the maximum, thus favouring the opinion that by early treatment a still further reduction in the first month should be possible. The number of cases of hydrophobia that undergo treatment in the successive days of the first week, however, is still too small for a definite pronouncement.

However this may be, the figures indicate that by treatment with monkey virus the maximum effect, attributed to the ideal hypothetical method, is really approached if not actually reached. Here a normal distribution had to be assumed, that is to say, an equal composition of the 4 groups as regards the occurrence in each group of cases of hydrophobia so far as those with short incubation periods among the latecomers have not, in the meantime, disappeared. This seems in contradiction to the present pronouncement that the severity of the wounding is of influ-

TABLE VI.

| Commencement of treatment ..... day after the bite. 1 | Calculated maximal incubation period with hypothetical treatment. 2 | Actual maximal incubation period with present treatment (monkey fixed virus). 3 | |
|---|---|---|---|
| | | without failures | failures |
| 1 —7th | 30 + 6 = 36 | 32 | — |
| 8 — 14th | 37 + 6 = 43 | 38 | 2 (43.90) |
| 15 — 21st | 44 + 6 = 50 | 45 | |
| 22 — 28th | 51 + 6 = 57 | 54 | — |

ence on the promptness of obtaining treatment. While under-estimation of the danger may, in an extreme instance, lead to wounded people, more especially those only slightly injured, not undergoing treatment, a part of them will, nevertheless, present themselves for treatment after a more or less short delay. For this reason, in the first week the severely wounded with proportionately more cases with short incubation periods will preponderate, while in the later weeks it will be the slightly wounded with longer incubation periods. Such a selection does indeed take place, but subject to the qualification "ceteris paribus," *i.e.*, when prompt treatment is available to all, as is usual in Western countries with their means of rapid communications. In Eastern countries, however, at any rate in a widely scattered archipelago like the Netherlands East Indies, depending on interinsular shipping communication, such an intentional selection is impossible [1]. In this country delay in treatment, even till the 3rd or 4th week, does not depend on the desires of those concerned but is the inevitable result of the long distances from the centre of treatment, Bandoeng. Not less than 80%—90% of those who come for treatment later than the 1st week originate from the "Outer Provinces," among them many with severe wounds and serious risks of infection. the other in 1933 with one of 3 months). Here, then, is proof, as already appeared from Table VI, that monkey fixed virus gives the highest results obtainable; even with treatment in the 3rd and 4th weeks the mortality rate is limited to the second month, or more precisely, to a period of not more than 30 days after the commencement of treatment.

That is not to say that thus the time of commencement of treatment would be of minor importance. On the contrary, the mortality after the first month, with treatment in the second week, is more than 14 times higher than with treatment in the first week (0.53: 0.036) while with treatment in the fourth week it amounts to even over 80-fold (295: 0.036). These differences are still more strikingly illustrated when expressed in absolute numbers on the basis of the number treated in the first week, *viz:* if, in each successive week this number had also been 5548, then the number of cases of hydrophobia later than the first month after the bite, with treatment in the 2nd—4th weeks, would have been 29, 47 and 163 respectively instead of 2 with treatment in the first week.

On the basis of the above it is clear that cases with short incubation periods with treatment in the first month, as well as those with incubation

TABLE VII. *Cases of hydrophobia* (1916–1940).

| Period of treatment | Number treated | Totals | | within 30 days of bite | | > 30 days of bite | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | number | % death rate | number | % death rate | number | % death rate | failures | % death rate |
| 1st week | 5548 | 50 | 0.90 | 48 (96%) | 0.86 | 2 | 0.036 | 0 | 0.— |
| 2nd week | 2643 | 49 | 1.85 | 35 (71%) | 1.32 | 14 | 0.53 | 2 | 0.08 |
| 3rd week | 822 | 15 | 1.82 | 8 (53%) | 0.97 | 7 | 0.85 | 0 | 0.— |
| 4th week or later | 373 | 13 | 3.48 | 2 (15%) | 0.53 | 11 | 2.95 | 0 | 0.— |

Where inverse selection is thus rendered impossible, the 4 groups are practically equivalent and so the results with monkey fixed virus (live and formalized vaccine) during the years 1916 to the end of 1940, set out in Table VII, are, as it were, those of an experiment on man.

In the first place we see how the percentage of cases in the first month after the bite become really smaller, according to the lateness of commencement of treatment: while with treatment in the 1st week, except for 2, all cases (96%) occur in the first month after the bite, this number drops clearly in the second and in the fourth week amounts to only 15%. This decline, however, — apart from the distribution of those treated and ignoring the effect of treatment — is to be expected, as has already been observed.

In the second place, however, the reduced mortality in all groups appears to be practically zero; only 2 failures were recorded among those treated with live virus in the 2nd week (the first in 1930 with an incubation period of 43 days, and

[1] As shown by the data collected by McKENDRICK, the mortality rate in Western countries usually falls with increasing delay of treatment; in Eastern countries, however, the mortality rate shows an increase according to the delay in treatment.

periods exceeding one month through delayed treatment, must inevitably appear with either method of treatment and that it is impossible to obscure the results when the cases are arranged according to the week of treatment as given in Table VII. This, then, is the reason why an emphatic warning is necessary against statistics which regard the success of a method of treatment as proved by the total absence of cases of hydrophobia. Statistics of this nature can be explained in only two ways: either rabies has been entirely eliminated in the area concerned or the information service is so unreliable that even cases with short incubation periods escape notice. For not a single rabies expert would deny the impossibility of preventing all cases of hydrophobia no matter how early treatment is started nor how active the method applied may be.

McKENDRICK, the only author who studied my Monograph with more than superficial attention, after serious consideration of the results of treatment with monkey brain fixed virus in Bandoeng, expressed the opinion that they were "unique" but, curiously, refrains from an explicit pronouncement on the method I suggest for the evaluation of results. Year after year this author continues to collect data from institutes all over

the world and, with the aid of extensive statistical formulae, which are difficult for the ordinary reader to assimilate, analyses the significance of variations in mortality with different methods of treatment, arriving invariably at the same negative conclusion, that none of the methods appears to be superior to the others without, however, venturing to acknowledge the inefficacy of them all. Nevertheless, however great may be the reluctance to admit the failure of anti-rabic treatment in the light of the proofs mentioned above, serious investigators in this field cannot escape the necessity of facing this fundamental question. They will have to respond to my proposal to analyse the effects of treatment in an entirely different method than by means of misleading mortality figures, a method of analysis which cannot be refuted by tacit silence.

SCHWEINBURG (1937) has refrained from any discussion of my Monograph, in his very extensive résumé on rabies, on the plea that this would fill another volume (in a personal letter to me, he said that he was an indifferent English scholar and that my method of analysis was not sufficiently clear to him). It appears to me that if one confines oneself to the principal question, that is, my proposed method of analysis and its application to the rabies statistics available, a single page or even a few lines would suffice to express an opinion. SCHWEINBURG could better have spared us the reading of numerous commonplaces on rabies, presented under the impressive title of "Neuere Ergebnisse der Tollwutforschung", which for the greater part owe their tradition to that absence of critical sense, so characteristic of the entire rabies literature, rather than to their authenticity.

in July 1930 according to the alternating system in order to obtain a clear comparison with live vaccine; in 1934 this comparative experiment was extended to treatment in the second week. The results were so satisfactory that since the 1st January 1938 treatment has been carried out with formalized vaccine exclusively; Table VIII gives a complete survey of treatment in the 1st and 2nd weeks (the figures for the 3rd and 4th weeks are still too small) up to the end of 1940.

The results of the alternating treatment show that the formalized vaccine is in no way inferior to the live. The final results rather show that — thanks to the higher initial dose — a greater reduction of cases within the first month after the bite is obtained with this formalized vaccine. Failures might also be prevented among those treated with formalized vaccine in the 2nd week which, with live vaccine, appeared only to be possible with treatment in the 1st week.

The formalized vaccine was first prepared by the addition of 1‰ of formalin to a 10% fixed virus emulsion which was afterwards heated for 24 hours at 37° C.; vaccine thus prepared is ready for immediate use by a 5-times dilution with physiological salt solution to a 2% emulsion. As the result of a case of paralysis, the concentration of formalin was increased to 1.5‰. Although about 2000 guinea pigs had survived intracerebral injection of consecutive samples (10 animals per sample) of this vaccine without any symptoms a second accident occured which, though not serious, showed undeniably that, in

TABLE VIII.

| Vaccine monkey brain | All wounds: number treated | All wounds: cases of hydrophobia: totals | All wounds: cases of hydrophobia: within 30 days of bite | All wounds: cases of hydrophobia: failures | Wounds of the limbs only: number treated | Wounds of the limbs only: cases of hydrophobia: totals | Wounds of the limbs only: cases of hydrophobia: within 30 days of bite | Wounds of the limbs only: cases of hydrophobia: failures |
|---|---|---|---|---|---|---|---|---|
| *treated in 1st week of bite* | | | | | | | | |
| alternating (15/7 '30—1/1 '33). | | | | | | | | |
| live | 348 | 4 | 4 | 0 | 315 | 1 | 1 | 0 |
| formalized | 352 | 3 | 3 | 0 | 311 | 1 | 1 | 0 |
| *totals* | | | | | | | | |
| live (15/6 '16—1/1 '33) | 2,753 | 33 | 32 | 0 | 2,500 | 13 | 12 | 0 |
| formalized (15/7 '30—1/1 '41) | 2,795 | 17 | 16 | 0 | 2,567 | 7 | 6 | 0 |
| *treated in 2nd week of bite* | | | | | | | | |
| alternating (1/1 '34—1/1 '38). | | | | | | | | |
| live | 273 | 5 | 3 | 0 | 250 | 3 | 1 | 0 |
| formalized | 274 | 1 | 1 | 0 | 250 | 0 | 0 | 0 |
| *totals* | | | | | | | | |
| live (15/6 '16—1/1 '38). | 1,731 | 35 | 23 | 2 | 1,596 | 20 | 8 | 1 |
| formalized (1/1 '34—1/1 '41) | 912 | 14 | 12 | 0 | 842 | 6 | 4 | 0 |

After the disappointing results with carbolized vaccine, for a detailed discussion of which reference should be made to my monograph, pp. 30—35, an investigation was made into the influence of formalin on the monkey fixed virus in order to lead to the preparation of a formalized vaccine on the lines of the active anatoxin as already obtained with it. I shall confine myself here to a short survey of the, partly comparable, results of treatment with live and formalized monkey (brain) vaccine in the 1st and 2nd weeks and of the method of preparation and dosages at present followed.

Treatment with formalized vaccine, provisionally limited to the first week, was commenced

spite of innumerable negative results in test animals, the fixed virus in the vaccine could not yet be regarded as completely dead. Man, obviously, is more susceptible to fixed virus infection than test animals (guinea pigs) as traces of live virus, which can no longer be detected by animal test, are still capable of causing paralysis, however slight, in man. It is thus only on the basis of considerable experience in the precise dosages that the absolute innocuousness of such an attenuated vaccine can be guaranteed. After this untoward experience, the concentration of the formalin was not further increased but the period of heating was prolonged to 5 days; after this there was no further sign of fixed virus infection.

This cannot escape notice as all people bitten remain under observation for 25—30 days from the commencement of treatment and thus the period in which these accidents can occur is then long past.

Moreover, to confirm the clinical diagnosis, and especially to exclude the possibility of mixed infection, that is to say of street and fixed virus, a number of parts from the central nervous system (proximal and distal parts of the medulla, med. oblongata, pes hippocampi, cortex cerebri and cerebellum) are regularly examined, with different staining methods, for Negri-bodies. In addition, irrespective of the results of the microscopical examination, intracerebral injections are made from all of the parts mentioned into 5 guinea pigs for each part, thus a total of 30 animals. Should any of these animals die within the incubation period observed for fixed virus infection (5—13 days after intracerebral injection of guinea pigs with monkey fixed virus) a second sub-passage with 5 guinea pigs follows, even though Negri-bodies are found. Although some 30 cases have already been investigated in this manner not a single case of fixed virus infection, either alone or in combination with street virus, has been discovered. Should the present dosage (daily injection of 80 mgm. during 2 or 3 weeks, with a pause in the latter case on the 11th and 12th days, thus making a total of 1120 mgm. for slightly, and 1520 for more severely wounded) still unexpectedly appear noxious, especially for Europeans, then this drawback could easily be met by smaller dosage during the first days or first week of treatment with or without compensation by an increase in the daily dosage in the later period of immunization.

Fortunately the stronger concentration of formalin, which out of necessity had to be adopted, has had no harmful effects on the results of treatment. On the contrary, this increase from $1^0/_{00}$ to $1.5^0/_{00}$ in the formalin content of the vaccine led to a considerable increase in the survival rate in pre-infectional immunization tests in animals (*vide* Monograph, p. 148, Table XI, etc.). For fixed virus formalized vaccine, just as for diphtheria and tetanus anatoxin, it appears that a definite formalin concentration and a definite period of heating are necessary to ensure the maximum of immunizing power. Further experiments with this formalized vaccine also showed, for example, that a still higher formalin concentration or a longer period of heating was not favourable to the potency of the vaccine. As the long period of the treatment is, in many respects, a drawback, the question arose as to whether, with the seriously wounded too, a period of treatment shorter than 21 days may, perhaps, suffice.

To answer this question the sera of a number of those bitten, among whom part had been treated for 14 and part for 21 days, were examined for the presence of rabicidal antibodies. The investigation of these rabicidal (neutralizing) antibodies and their significance are dealt with in a separate chapter, so only a few words as to the technique will suffice here. Of the serum 1.5 cc. undiluted and once diluted, respectively, are each mixed with 1.5 cc. of a 1% suspension of monkey fixed virus and after 24 hours binding at room temperature, 0.2 cc. of the mixture is injected intracerebrally into guinea pigs. Thus with 0.1 and 0.05 cc. of the serum, respectively, there will be injected 1 mgr. of fixed virus of which the d.l.m.c. is 0.0025 mgm. Survival of a guinea pig, therefore, means that 400 and 800 d.l.m.c. respectively, are neutralized by 0.1 cc. of serum, and 1 cc. of serum contains sufficient antibodies to neutralize 4.000 and 8.000 d.l.m.c. respectively. One could, of course, experiment with a lower number of d.l.m.c. (for example with a ¼% fixed virus suspension on 1,000 d.l.m.c.) but this dosage was selected as it seemed that, with an orientating investigation, the difference in rabicidal potency between sera after 2 and 3 weeks' treatment would appear most clearly.

TABLE IX. *Treatment with formalized vaccine* ($1.5^0/_{00}$, *5 days heating* $37^0$ *C.*) *examination of serum* (1 *cc.*) *after*

| Period of treatment | 14 days d.l.m.c. | | | | 21 days d.l.m.c. | | | | 30 days d.l.m.c. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4.000 | | 8.000 | | 4.000 | | 8.000 | | 4.000 | | 8.000 | |
| | results | death rate | results | death rate | results | death rate | results | death rate | results | death rate | results | death rate |
| weeks | 46/120 | 38.3% | 91/120 | 75.8% | 55/160 | 34.3% | 102/160 | 63.8% | 33/170 | 19.4% | 69/170 | 40.6% |
| " | 30/90 | 33.3% | 64/90 | 71.1% | 41/160 | 25.6% | 82/160 | 51.2% | 22/150 | 14.7% | 60/150 | 40.–% |
| weeks | 41/110 | 37.3% | 81/110 | 73.6% | 41/110 | 37.3% | 72/110 | 65.5% | 21/110 | 19.1% | 42/110 | 38.2% |
| " | 30/90 | 33.3% | 64/90 | 71.1% | 24/90 | 26.6% | 40/90 | 44.4% | 17/90 | 18.8% | 38/90 | 42.2% |

The result of this serological research is set out in the above Table IX, in which per person for each dilution after each period 10 guinea pigs were always used.

As was to be expected, after 14 days, *i.e.* when after complete treatment 14 × 80 = 1,120 mgm. will have been injected, and after treatment of 3 weeks, 12 × 80 = 960 mgm., little or no difference existed. After 3 weeks, in which the longer treatment is also completed (19 × 80 = 1,520 mgm.), the sera of the 14-day treated remain a little behind, but after 30 days this difference is completely eliminated. This also appears from the bottom two rows of the table which give the data relating to 11 and 9 people whose sera were fully examined after 14 and 21 days' treatment, respectively, and from which the results are, therefore, exactly comparable. Now, too, with the shorter treatment, the increase in rabicidal potency in the 3rd week still remains a little behind gaining, however, after 30 days the same level as in treatment of 3 weeks.

On the basis of this small difference it is hardly possible to judge whether the 14-day treatment remains behind that of 3 weeks, the more so where there is no exact parallel between the degree of immunity and the rabicidal antibody content.

Consequently, in order to arrive at a definite conclusion on this point it is necessary to carry out a test by the alternating system, that is to say, to treat all severely wounded for 14 and 21 days alternately; the result of this must still be awaited.

*Conclusions.*

1. Mortality rates of hydrophobia among treated are useless in the evaluation of the effects of treatment.
2. Irrespective of the number treated, the division of cases of hydrophobia according to the incubation period — having regard to the interval between the bite and commencement of treatment — gives a correct insight into the effects of treatment.
3. By the application of this statistically completely reliable method of analysis, it becomes clear that all well known methods of treatment fail and that only monkey brain fixed virus, either living or killed by formalin, gives satisfactory results.
4. This is confirmed by animal test provided proper precautions are taken.
5. Many years of experimental research have proved that the activity of a fixed virus vaccine is governed by the species of animal used and also by the nature and concentration of the rabicidal agent.
6. By the use of monkey brain (10% emulsion) and formalin in a concentration of 1.5‰ with a heating period of 5 days at 37° C., a fixed virus vaccine is obtained which is of superior activity both in animal experiment and in the treatment of man.

*Explanation of protocols.* — For the sake of completeness the results of all experiments relating to this experimental research are set out in concise protocols. Nos. I and II cover the experiments for the years 1935–'40. In these, immunization was performed on at least 25 test animals per group in 3 injections with polyvalent fixed virus (mixture of 3 brains, *c.q.* cord, of the same animal species). Protocol No. I gives the results of infection with street virus and No. II those with fixed virus. Protocol III contains the experiments of former years (1929–'34) so far as they relate to the points under discussion. In these immunization was usually performed on not more than 10 test animals per group in 3 injections or daily (14 days) with monovalent fixed virus. Column 8 contains the combined results of 4 different dosages, Column 10 of 3 different methods of giving the same dosage, while in Column 17 the combined results of 8 comparable experiments are given. Infection was always carried out with street virus.

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* For a detailed list of the literature reference should be made to the Monograph of MARIA J. VAN STOCKUM, page 132.

# PALEOBOTANICAL RESEARCH IN THE NETHERLANDS INDIES, ITS PAST AND ITS FUTURE


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**Short Historical Outline and Problems of Paleobotanical Science:** — For more than a hundred years, paleobotany has been studied as an independent branch of science. Pioneers in the field, Baron VON SCHLOTHEIM and Count VON STERNBERG were the first to publish rather extensive works on the subject (1820, 1838). The *founder* of paleobotanical science is doubtless ADOLPHE BRONGNIART, whose main study, "Histoire des végétaux fossiles," appeared between 1828 and 1838; unfortunately it was not completed.

BRONGNIART's contribution to scientific development was that he did not confine himself to methodical considerations and systematic descriptions of fossil plants; he also outlined the sequent phases in the development of the flora during geological history. BRONGNIART recog-

* Revised and condensed from the author's "Honderd Jaar Palaeobotanisch Onderzoek en over de toekomst ervan in Ned.-Indië" *in De Mijningenieur* 8:55–65 (1927). The Editors of "Science and Scientists in the Netherlands Indies" are under obligation to WILLIAM C. DARRAH, M.A., for his assistance with the proofs during the absence of Dr. WESTERMANN.

nized in the oldest known strata plant remains of algal appearance. The Carboniferous Period yielded a vegetation characterized chiefly by *Calamites*, *Lepidodendron* and fern-like forms. In the Mesozoic Age, the most important part was played by the gymnospermae, which in their turn became secondary to the angiospermae in the Cenozoic Age. The morphology of the Carboniferous vegetation reminded BRONGNIART of the present humid, tropical jungle with its tree ferns; thereupon he concluded that the climate of the Carboniferous Period had been very warm. Thus, his studies of fossil plants — together with the discovery of the peculiar sequence found in the geological appearance of the main vertebrate animals; *i.e.* fishes, amphibians, reptiles and mammals — constituted a set of important arguments in favour of the theory of evolution thirty years before that idea was expounded by DARWIN.

After BRONGNIART's death, his fundamental studies were carried on by several students of fossil plants. In the next half century emphasis was placed, however, on the systematic-descriptive branch, and monographs particularly of the fossil floras in various coal districts were published. In later years these descriptions were of great value to the geologists who began to use paleobotanical species and genera as index forms for the various beds.

The systematic branch of paleobotany — describing and classifying the imprints and thin carbonized films of stems and leaves — is closely allied with the geological sciences on the one hand and with plant-geographical problems on the other. This is not the case with the investigation of those plant remains the internal structure of which could be successfully studied. This anatomical branch developed slowly, handicapped as it was in the beginning by the scarcity of material and by primitive technical methods. Only since about 1870 — after the more general introduction of the so-called "thin sections" (first developed around 1832) — has our knowledge of the anatomy of petrified plants been greatly expanded.

Although of little practical value for the geologist, this paleobotanical anatomy has yielded conspicuous results on purely botanical grounds. Comparatively speaking, publications in this field contain more general botanical knowledge than those dealing with systematic-descriptive paleobotany. It is also true that in recent years botanists, in an attempt to prove certain theories, have made use of arguments borrowed both from living plants and from paleobotanical anatomy.

It is due particularly to this new anatomical research in paleobotany that highly important discoveries have been made. It has been found that many of the Middle Devonian plant remains, formerly identified as algae (Thallophyta), actually belong to a quite different group. They form part of the Pteridophyta, in particular of the class of the Psilophytales, differing from recent forms by possessing terminal sporangia. Many of these oldest known land plants are now classed under the name of *Psilophyton*.

Likewise, contrary to the old views, it could be proved that by far the greatest part of the so-called "fern leaves" in the Paleozoic beds are leaves of true seed plants and belong to a group closely affiliated through the structure of their seeds with the recent gymnospermae: Pteridospermophyta, also called Pteridospermae ("seed ferns"). These seed plants were found to have reached an advanced stage of development even in the oldest beds that contain plant remains. Their distribution is by no means more limited than that of the Paleozoic Psilophytales, discussed above. Particular attention is drawn, for instance, to the presence in the Middle Devonian Period of highly developed seed plants with needle-shaped leaves.

It was just mentioned that most of the Paleozoic "fern leaves" are now recognized as the leaves of seed plants. The remaining few of these fern-like leaves are still thought to belong to the ferns, and are supposed to be related to certain structure-revealing remains known as Psaronieae and Inversicatenales, "families" of the class Filicales.[1]

In review, it is seen that this new anatomical research has resulted in a re-classification of the Paleozoic plants, with the general tendency to place the various types in higher phyla than those in which they had formerly been put. Thus, part of the "Algae" have become Pteridophyta (Psilophytales), and part of the former "Pteridophyta" ("ferns") are now seed plants (Pteridospermae). The systematic "standard" of plant life in the Paleozoic Age has, consequently, been appreciably raised, and the discovery of seed plants in the Middle Devonian Period upsets the simple paleobotanical succession as recognized by BRONGNIART in the second quarter of the Nineteenth century.

The types of vegetation in the forests, swamps, etc. certainly were not less complex in the Paleozoic Age than they are at present. It is merely because of the poor preservation of the older plants that our knowledge of them is very limited. Devonian beds still show a fairly representative fossil flora of relatively high development. The scarcity of plant remains in the pre-Devonian strata should probably be ascribed to the small possibilities of fossilisation (as a consequence of the unfavourable facies), but rather than to the slight development of plant life at that time.

Palaeontological records show analogous phenomena. In the fossiliferous Cambrian and Silurian beds is a fauna which — if we take into account the possibilities of preservation — was certainly not poorer than a comparable fauna of today. The numerous species of *Trilobites* and other arthropods, the brachiopods, corals, *Graptolites*, and several other groups are ample proof of this thesis.[2] The rich variation and the degree of specialization of these forms, some of which were of considerable size, strongly suggest that these Lower Paleozoic faunas were not the representatives of the first beginnings of life. Actually they must have been the rather specialized offspring of ancestors which has lived and developed for millions of years during the so-called Azoic Period, of which hardly any traces of life have been left. SEWARD (1933) rightly remarks that the term Azoic ("without life") is "a designation which

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[1] The Psaronieae form the Paleozoic "family" of the order of the Eufilicineae or "true ferns." The name "Inversicatenales" is a substitute for that of the family of the Botryopteridae, introduced by P. BERTRAND in 1909, but not generally accepted. They belong to the order of the Coenopteridae, the latter representing a group of Paleozoic ferns.

[2] The abundance of soft-bodied life in these early periods was revealed by C. D. WALCOTT's discovery of the wonderful fauna of the Middle Cambrian Burgess Shale (British Columbia), containing well preserved remains of seaweeds, siliceous sponges, jellyfish, annelid worms, crustaceans, and merostomata.

stirs the imagination, though inappropriate, because it implies more than can be proved."[3]

Similarly the highly organized Devonian flora must have developed from geologically much older, pre-Devonian plant life which, because of a lack of proper conditions, was not preserved (graphite and certain deposits of iron ore in pre-Cambrian rocks have been mentioned as indicative of plant life).

Thus instead of the theory that organic evolution took place solely in those periods of which fossil remains of life are actually found, it may be rightly assumed that this evolution started long before these periods, and that the latter have been relatively short in comparison with the preceding "a-zoic" time. In this respect it is worthwhile to remark that the Azoic or pre-Cambrian rocks in North America are of such a thickness that geologists consider them to represent at least half of the period of 1600 to 2000 million years which elapsed after the first sedimentary rocks were deposited! (HOLMES estimated the pre-Cambrian sedimentary period at 900 million years at least, the period from the beginning of the Cambrian until now at approximately 700 million years.)

There is also the possibility that the organic evolution is periodic and that there might have been a strong interrelation between the development of life and the sequence of various climates through the ages. No longer can KANT and LAPLACE's theory that the surface of the earth has been growing steadily cooler since its crust became solid be accepted. After this solidification was achieved, the internal temperature of the earth ceased to affect conditions on the surface to any great extent. There are several indications of oscillations in climate and temperature during geological history: warm climates in the Carboniferous and Tertiary Ages; glacial periods in Lower Algonkian, Lower Cambrian, Lower Devonian, Permian, and Pleistocene Periods.

Any intermittent evolution of flora and fauna, whether materially influenced by varying climatic conditions or not, might have presented itself as changes in the mutual relation of the various organs, different for each group. As a consequence of such a process, certain specializations in morphology and physiology could have become effective, creating diversity in plant and animal life.

**Paleobotanical Research in the Netherlands East Indies and its Future Possibilities:** — The future possibilities of paleobotanical science in the East Indies vary considerably with the geological age of the fossil plants to be studied. Each period has its own problems and will, therefore, be treated separately.

In the Netherlands Indies, plant remains from the *Paleozoic* Age have been known for only a few years. In the upper area of the province of Djambi (Sumatra) numerous plant imprints have been found in young Paleozoic rocks, considered as either Lower Permian or transition beds between the Permian and Carboniferous Periods. The geographical position of Djambi between India and Australia — the two principal locations of the young Paleozoic Gondwana-Glossopteris flora — would make one expect that the Djambi flora is also of the Gondwana type. However, this flora appeared to be affiliated rather more with the so-called Arcto-Carboniferous plant association found in Europe, America, and northeast Asia, which differs considerably from the Gondwana flora. Later discoveries in Djambi of forms also known in North China (Shan-si) have corroborated this impression. A similar fossil flora was recently found by SCRIVENOR in Kelantan (Malay Peninsula), and described by EDWARDS. All this confirms our opinion that in Paleozoic times the Sumatran land was a southern spur of the northeastern Asiatic territory.

In other words, the boundary between the areas of Arcto-Carboniferous and Gondwana floras must have been situated somewhere southwest of Sumatra. Practically no data are available, however, regarding the extension of this line. It is true that in 1885 TENNISON WOODS mentioned a Lower Gondwana flora from Serawak, but this record has not been affirmed, and only a further examination on the spot may throw new light upon the subject.

Continued study of the Paleozoic floras will probably increase the possibilities of parallelization, either by finding borderland deposits with mix-floras, or by the discovery of correlative marine fossils between the beds of both the Gondwana and Arcto-Carboniferous floras. At the same time one may get an idea of paleogeographical problems. There may be found bases for judging in how far India, Australia, South Africa, southern South America — *i.e.*, the countries with the Gondwana flora — have become separated by subsequent horizontal movements of their continents. Of special importance in this respect is, of course, the conjectured presence of a Glossopteris flora in Sarawak (mentioned above) and its relation to its position northeast of Djambi, where Arcto-Carboniferous plant remains were discovered.

The conjectures concerning the *Mesozoic* floras may rightly be called unlimited. Plant remains from this period have been found in the Triassic of Ceram (RUTTEN, 1918) and of Boeton (ZWIERZYCKI, 1925); so far they have not been identified.

The nearest country in which synchronous floras are known is Indo-China. Here, in Upper Triassic deposits one finds certain Gondwana types next to a number of forms at that time widely distributed over Europe and America. Consequently, one gains the impression that the Gondwana flora expanded its distribution during the first half of the Mesozoic Age and mixed with the descendants of the Arcto-Carboniferous flora.

The differences in the floristic composition of the two groups appear to have decreased more and more during the Mesozoic Period. The greatest uniformity was reached in Middle Jurassic time, as far as can be judged from the known floras. The fossiliferous Middle Jurassic rocks of Singapore unfortunately yielded a flora too poor to get a clear idea of its components.

From our knowledge of Indo-China we expect that there had been an increase of the Gondwana elements in the Netherlands Indies during the first half of the Mesozoic Age, and that they mingled with other forms. In the Cretaceous flora, even then of a rather uniform character, there will be possibly found the first angiospermae, although the fact that the latter had appeared in the East Indies in an even earlier period has not been overlooked.

There is an abundance of material, both imprints and silicified wood, of the flora of the Ter-

[3] Other names employed for the earliest periods of geological history connote the probable existence of primitive life: Eozoic ("dawn of life"); Cryptozoic ("hidden life").

tiary Period, in many locations and of various ages. In some places silicified wood is found in enormous quantities, and is often very well preserved. Its study is extremely attractive because it gives an insight to the evolution of the tropical angiospermae, uninfluenced by great changes in climate (otherwise than the evolution of the angiospermae in the Northern Hemisphere!).

The study of Tertiary plants is, however, handicapped by several difficulties of a special kind. A comparison with the study of plants from earlier periods will elucidate this point.

In *pre-Tertiary* floras the species show only remote affinity to recent plants, and are, therefore, studied independently, for the most part. They are types of principal groups that at present have but few, and very different representatives. In case it becomes necessary to determine their systematic place by comparing them with recent material, it is sufficient for the paleobotanist to refer solely to fairly large groups of recent plants. Detailed comparison with the living flora is seldom required.

In the determination of *Tertiary* plants, on the other hand, it is desirable to obtain as close a contact as possible with the recent genera and species. Because the most characteristic elements of the angiospermae, *i.e.* the flowers and fruits, are practically always lacking, it is absolutely necessary to have available abundant comparable material, and to possess an adequate knowledge of the living tropical flora. Warning examples in this respect are the identifications made by HEER, VON ETTINGSHAUSEN, and others, of a great many species, and based on similarities in the shape of the leaves. Afterwards, part of their identifications proved worthless, first because they were made from insufficient material, and second because they were based on inadequate knowledge of the present tropical flora.[4]

The study of the Tertiary flora in the Tropics can be carried out successfully only if coordinated with the study of the present tropical plant life and preferably by a botanist who has worked a long time in the Tropics and who wants to specialize in this branch of science. There are no flowers and almost no fruits and seeds in the Tertiary remains. It is necessary, therefore, to work with the characteristics of vegetative parts, like venation, structure of the cuticula (after maceration), etc., an examination possible only if the comparable recent material is well known. In connection with the great mobility of the European population, it remains to be seen whether such a prolonged investigation would be possible here. The anatomical examination of fossil wood is not subject to this limitation; in this study important results have already been achieved.

Paleobotanical study is hampered by difficulties not met in purely botanical or geological research. For instance, an herbarium is in most cases light in weight, and can be taken along easily and without much risk. But collections of fossil plants to be used as comparable material, are too heavy, and its components are frequently too fragile to be transported. The present collections of fossil plants are kept in widely separated places, usually as a part of geological collections from certain areas. It goes without saying that this is a great deterrent to getting a general view of the available material. For geological museums the possession of extensive fossil plant collections is not always of great importance. Only the index forms, geologically rather widely distributed and characteristic for special horizons, are of value for the geologist. Most of the material, consisting of types present in only few specimens, has little geological importance, but is often of great value for the botanist, and in fact should be kept in a botanical museum.

Considerations of this kind led in 1885 to the creation of a separate paleobotanical department in the Museum of Natural History in Stockholm. It is now part of the Botanical Museum, and contains collections donated by other museums and by the Geological Service of Sweden. In this paleobotanical center the material has been properly distributed and subdivided, and consequently has become more accessible for study. Here paleobotany is recognized as a part of the botanical science, and not as an auxiliary branch of geology.

Tradition will in many cases be a deterrent to the desired concentration of widely scattered paleobotanical collections into one separate paleobotanical institute. The fossil plants collected in the Netherlands Indies, for instance, are kept in various museums in Leiden, Utrecht, Groningen, Delft, Bandoeng, Buitenzorg, Dresden, München and Basel. If most of these collections could be brought together in a museum or institute especially set up for the study of the fossil flora of the Indies, further examination would be greatly facilitated. For a scholar to have in his vicinity an herbarium with easily accessible material of the recent Indian flora would naturally be very helpful, particularly for the study of the Tertiary plants.

Such a centralization would require the full co-operation of the various institutes and museums now in possession of the collections. The geological institutes would be entitled to obtain duplicates of stratigraphically important plants, as a compensation for the collections handed over. The botanical institutes could claim valuable floristic duplicates. Original specimens should, however, be kept in the newly created museum. The nucleus of this new collection could, for instance, consist of the Permo-carboniferous and Tertiary plant material from Djambi, collected by the writer by order of the Royal Netherlands Geographical Society and others; the future status of this collection has not yet been determined. After preparing the descriptions of the more than 1800 specimens, the museum would have the responsibility for the disposal of a great many duplicates, part of which could be given to various institutes, as a compensation for collections received from them. Other duplicates might be used for exchange with foreign museums. In this way it might be possible to obtain Gondwana plants from India and Australia, Permian specimens from China, and Mesozoic material from Indo-China, collections extremely valuable for comparison with the East Indian fossils.

Close co-operation with the "Dienst van het Mijnwezen in Nederlandsch Indië" is strongly recommended. "Mijnwezen" has good opportunities to collect fossil plants during its geological exploration, and could supply the museum with abundant material. After the examination

[4] It is evident now that the separation between fossil and living angiospermae is impractical. In this respect it is significant that the present textbooks do not or only subordinately deal with this group.

of the specimens, the index species would be returned in order to complete the stratigraphical collections of "Mijnwezen." At the same time "Mijnwezen" could profit by the age determinations and other geological conclusions reached by the paleobotanist.

For the time being, it is of little importance whether or not the museum is managed by a paleobotanist. What is more important is that funds should be available to defray the expenses of transportation and preparation of the material, to finance the examination by various specialists, and also pay for publication. Only if the museum has a sound financial foundation can it be a central institution with sufficient power of initiative. In certain instances, it would be desirable that field collecting be carried out by the museum itself, either independently or in co-operation with others.

Where and how should this Paleobotanical Museum be organized? In the Indies or in the Netherlands?[5] Within or outside a university? As a separate institution or as a dependency of a botanical museum? These questions should be answered while the paleobotanical exploration of the Indies is still in the initial stage. Later on, after large new collections have been divided among various scattered museums, the execution of this project will meet with far more difficulties.

[5] It is thought that it would be both practical and fair to store the plant fossils of the Indies in a Netherlands Indies Paleobotanical Institute. Modern means of transportation between Java and the rest of the world considerably reduce the objection of the great distance from other paleobotanical centers. Literature, now still scanty, can be procured from everywhere. The presence of a rich botanical collection in Buitenzorg, and, shortly, of a well-equipped geological museum, is strongly in favour of establishing this new paleobotanical center in Java.

# THE HOT SPRINGS CONFERENCE AND AGRICULTURE IN SOUTHEAST ASIA

*by*

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The United Nations Conference on Food and Agriculture was a gathering of representatives of all the United Nations and of all those associated countries which had taken a definite stand in the present world conflict by breaking off relations with the Axis. The purpose of this first conference of the United Nations was threefold: to promote international coöperation in scientific agriculture; to devise measures for improving the diets of people throughout the world; and to insure a better future for post-war agriculture and consequently for all those who make a living in that vital branch of human activity. This paper will tell what the Conference sought to accomplish, or at least to prepare, in the third field.

One need not dwell long on the wrongs done agriculture in the inter-war period when the markets for staple commodities were seriously disrupted. Yet, even in the midst of the period of war shortages, when there was strict rationing in Great Britain and tragic under-nourishment in the occupied countries of Europe, the spectre of over-production and of worthless agricultural commodities was never absent from the minds of those gathered at Hot Springs. True, in the near future these shortages may become even more acute, and they may well outlast this war for several years. But on the other hand, recent experience has taught that agricultural production can be raised substantially even while many millions of farmers are being drawn into the armed forces. Britain has succeeded in revitalizing its almost forgotten agriculture and can now raise a substantial part of the food it needs. Canada has increased its exportation of dairy products while maintaining its wheat crops at or above pre-war levels. In the United States as well as in Germany, at least one major commodity has been largely replaced by a synthetic product, and no one would dare say that the chemical industry is not in a position to make further progress along those lines before free access to all commodity-producing countries is restored. Hence, there were many good reasons to consider the long-range future of agriculture, and to see what international coöperation can do to improve its prospects.

In peacetime the countries represented in Hot Springs controlled seventy-five to eighty per cent of the world's trade. Of the leading exporting agricultural countries, only Argentina was absent. This in itself gave weight to the Conference. The atmosphere in which the problems were approached was one of mutual understanding, befitting nations engaged in a common struggle. No immediate issues of a conflicting nature were involved, and the technical preparation of the Conference by the United States delegation had been excellent; therefore, without undue loss of time, the many and complex questions could be examined.

The main problem which confronted the Economic Section of the Hot Springs Conference was the taking of some kind of international action to assure adequate prices for agricultural commodities. There was general agreement that such action should neither demand a reduction in output, nor freeze production on present levels. The purpose was rather the opposite: an expanded production at remunerative prices. In order to attain such a goal, the delegates recalled and recommended enforcing such commodity agreements as had been in existence during the inter-war period — the international agreements on the production of tea, rubber, tin, etc., for instance.

True, criticism of the way in which the international controls had operated in the past was

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

not entirely lacking, but such criticism came from persons well acquainted with the actual situation who, therefore, took into account the state of virtual breakdown in agricultural production at the moment when the controls started. Consequently, this criticism was unbiased and constructive, as well as forward-looking.

There was one single though vigorous attack on the entire system of any application whatsoever of any control the purpose of which was to stabilize agricultural commodity prices at an adequate level. But this voice, raised by a representative of a typical consumer nation, failed to find response in the Conference. The old economic principles of the days of RICARDO sound very well, but none of those present failed to remember to what utter disorganization the constantly falling agricultural prices had led all countries in the inter-war period.

Every nation represented at the Conference, — industrialized nations like the United States and Great Britain included — at present consider a sound agriculture an indispensable element of the national life. Consequently, commodity agreements tending to insure a constant and fair income to farmers would be welcomed everywhere. Furthermore, the original distinction between agricultural production countries and consumer nations no longer holds good. Great Britain, the typical consumer nation of the past, has laid great stress on the reconstruction of its own agriculture, for obvious political reasons. At the Conference it did appear that Great Britain was not prepared to return to the principle of laissez-faire in matters pertaining to its own agriculture. In fairness Britain could not, therefore, find fault with other nations, much more predominantly agricultural, who sought to do the same thing, even though such arrangements tended to raise the prices of exported agricultural commodities. The exporting agricultural nations emphasized the fact that slumps in agricultural prices greatly affect their purchasing of industrial commodities, thereby endangering the position of exporting industries in manufacturing countries as well.

One more important element was stressed with regard to future commodity agreements: the consumer nations should have a qualified voice in the determination as well as the application of these agreements. There was general accord with this principle which, if well applied, should eliminate all fear that the agreements would virtually amount to large cartels binding the consumers without any regard for their interests.

As a particular form of commodity agreement, or as a possible substitute in certain fields, the building of stock piles for the purpose of erasing excessive price fluctuations from year to year was recommended. Clearly, the policy regarding the use of such buffer stocks should be determined internationally; otherwise their effect on prices might well be disturbing rather than stabilizing.

The determination of this set of principles — and that almost unanimously — was gratifying. But how are those principles to be translated into actual policy? Here the task was left to a permanent organization, which the Conference decided to create. This conclusion may seem somewhat disappointing in view of the high hopes which the spirit of the entire Conference seemed to warrant. However, one should reserve a definite opinion, and let the permanent organization do its work for some time to come. Naturally, the practical problems are so vast that none could really have expected more than what was accomplished during the few weeks of discussions at the Conference.

When the consequences of this work are considered with special regard to southeastern Asia, the same mental reservation must be made. The countries of this part of the world are so predominantly agricultural that the solution of the problem of how to obtain remunerative agricultural prices is of paramount importance to them. The staple food of the area, as well as that of other large areas in Asia, is, of course, rice. The delegates for the Netherlands Indies had some interesting statements to make about the establishment of adequate prices for rice. For a considerable period the authorities there have seen to it that the price of rice has not been subject to undue fluctuations from time to time, nor from region to region. The price regulation established adequate returns to producers and made a not-too-expensive product available to consumers. Occasionally the government sold rice much below cost in order to help out famine ridden districts; but as a rule, the application of the system did not require additional funds.

This arrangement, important as it was, could not do much to insure adequate prices for rice on the world market, for the Indies are almost self-sufficient so far as this food is concerned. An international arrangement along similar lines, which might have greatly benefited exporting countries such as Burma, Indo-China, and Siam, would have strengthened rather than weakened the already existing national control of the Indies; it would also have done away with the typically protectionist tendency which, in the long run, threatens national control of the price of every article which remains subject to violent fluctuations elsewhere.

Most of the other agricultural commodities of the East Indies were formerly exported on a large scale. Whether they are produced predominantly on modern plantations where scientific methods are used or whether they are cultivated mostly in native gardens, the significance of their prices for the native population is very great, both directly and indirectly. This is abundantly shown by the effect of the latest sugar crisis in Java, starting in 1932 and leading to drastic reduction in the cultivated area rented by sugar estates. The terrific slump affected the amount as well as the scale of the wages paid out, the rent received by the native landowners, and, indirectly, the income of the entire population of certain thickly settled districts of central Java. Similarly, the virtual collapse of the rubber market, which preceded the control of the International Rubber Regulating Committee, brought misery to the once prosperous Djambi district on Sumatra — as it did to many other districts — where almost all the rubber is grown in small gardens owned by Indonesians or Chinese. Again, the low prices for copra, a typically native product, which prevailed until the outbreak of the war in Europe, had a depressing effect on the population of the entire eastern half of the archipelago.

It is useless to multiply these examples; similar ones might be given for almost any uncontrolled agricultural commodity, and for almost any region on earth. The arguments of the classical

economists — that shifts from one type of crop to another, more remunerative crop should be made — simply do not hold good. These slumps appear simultaneously or in rapid succession; and the painful process of shifting from one crop to another, while useful or even necessary in certain instances, would tend, for the most part, to disrupt the market for the new product as badly as for the one which the farmers had been induced to abandon. In all those cases where a potential demand for a certain commodity exists, its price might be maintained at a satisfactory level through international arrangements.

Great as these benefits would be to predominantly agricultural countries like those of southeastern Asia — in fact, they would benefit the entire world — their successful operation would be impaired if special preferential treatment were continued not only for many national crops, but equally for those of other countries linked with the protectionist country by some special political tie. It should be stated in all frankness that prospects for the removal of those restrictions do not appear very bright just now. On the other hand, one may entertain at least some hope that, once a satisfactory world price for a certain crop is established, the needs for the special protection of the market may be felt so much less that the restrictions, if maintained at all, will be decreased rather than increased.

Although there are outstanding examples of successful control — such as the Inter-American coffee agreement first effective in 1940 — the difficulties of establishing and maintaining these arrangements are not to be underestimated. The best procedure ought to be to start with products which have a specific use and for which there is no substitute. The inclusion of the potentially great European market in the coffee agreement might offer a good starting point. The East Indies, the ranking coffee producer outside the Western Hemisphere, would certainly benefit by such a development, reorganizing as it would the market of a commodity which had been over-produced for several decades. In the entire economy of the Indies, coffee is no longer of primary importance, although it is a main export commodity in some districts of Sumatra and Java. Cocoa, of which the Indies also produces a crop, though a comparatively small one, might offer another example of a product the market for which has shown the need of an international agreement. There, too, the situation in countries producing the commodity is such that the conclusion of a cocoa agreement would not be too difficult. The future of the existing international agreement on tea should be rather well assured for similar reasons.

In the case of rubber — a product officially outside the scope of the Conference, but so vital to southeast Asia that one simply cannot ignore it — the continuation of the pre-war agreement would be impossible, if only because of the development of the synthetic industry. If southeastern Asia is to be permitted to march forward to greater prosperity as it should — thereby making it possible, among other important things, to improve its diets — some commodity agreement which allocates a certain limited field to synthetic rubber and also continues to regulate the prices for natural rubber should be reached. Within certain limits, the same holds true for cinchona — a product also ruled from the Conference's agenda. More difficult still would be the conclusion of satisfactory international agreements on a vast array of competitive commodities which are produced in equal quantities in southeastern Asia: fibres, fats, and vegetable oils. Particularly in the last two fields, closely related to each other, the difficulties would be very great because several animal fats, and to a certain extent even mineral fats, compete with them for various uses. Only if agreements were reached with regard to other commodities, the list of which should also include many of relatively slight importance for southeastern Asia — as well as, possibly, tobacco — might it be possible to affect agreements for the groups of interrelated products.

All in all, there is a great amount of economic work to be done by the permanent international committee concerned with food and agriculture, which the Hot Springs Conference decided should be constituted and plans for the organization of which are now being formulated by an Interim Commission. Upon the success of this undertaking, which was initiated under such favorable auspices, depends much of the development of the Netherlands Indies and the surrounding countries in the years immediately ahead.

# RECENT RESEARCH AT THE DELI TOBACCO EXPERIMENT STATION

*by*

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The staff of the Deli Tobacco Experiment Station consists of a Director, four departmental chiefs, a secretary, an assistant, an analyst, and sixty natives. It is exclusively concerned with the cultivation of cigar-wrapper tobacco produced from a yearly area of 30,000 acres in a rotation of about eight years (half year tobacco, half year rice, seven years jungle).

The work is divided among four departments, each headed by a specially trained chief: (1) agriculture, (2) botany, (3) entomology, (4) agrochemistry. There is also a department for administration and correspondence that is re-

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sponsible for meteorological data (particularly rainfall) and a statistical summary of field data (*Bulletin van het Deli Proefstation*).

An account is here given of the results of research work during the last five years or so. They are published in detail in special publications or in annual reports which appear as *Mededeelingen van het Deli Proefstation.*

**Agricultural Department** (Ir. VAN DER POEL; Dr. ROELOFSEN):—

*Manuring.* — Fertilizer experiments are made almost exclusively to improve quality, not to increase yields. Although fertilizer experiments have been carried out for half a century, so many new problems are continually cropping up (partly as a result of changes in market requirements) that fertilizing is the chief item on the programme of the Agricultural Department. In the last three years the work has been done by agriculturists engaged by the great tobacco companies.

The normal fertilizing varies with the soil type. Before planting, a mixture of 0–25 gm. of basic slag, 0–2 gm. of $K_2O$ in the form of tobacco-plant ash, and 5–15 gm. of sulphate of potash per plant is broadcast, and 10 gm. of a 5–10–7½ or 5–20–7½ NPK mixture is applied in the planting hole.

It has been demonstrated that a broadcast application of 1·5–2·0 gm. per plant of $K_2O$ in the form of ash a week before planting produces a more uniform and pliant tobacco. This treatment also makes it possible to give more basic slag so as to get a brighter tobacco and larger leaves without the drawbacks of variegated, yellow or reddish coloration, and a too dry and short character. Sulphate of potash has the same effect as ash with the additional advantage that it does not give rise to so moist a tobacco.

It has been found that 20 gm. of basic slag per plant always gives good results on the phosphate-deficient, residual red and black soils, and careful studies are going to be made to determine the optimal doses of slag and ash for the less phosphate-deficient alluvial soils. Since the outbreak of war basic slag has been unobtainable, and experiments have been initiated to test the value of local sources of phosphate. Pre-war experience had indicated that basic slag was preferable.

Tests on the black dust soils with an additional dressing of P and K after plucking the sand-leaves indicate that the quality of the higher leaves is thereby improved; N is of little or no use.

Variation of the N–P–K ratios of the fertilizer applied in the planting hole has a much greater effect on tobacco quality than variation of the actual quantity applied, or than variation in the earlier fertilizing. At the present time the main object of research is to determine the optimal amounts of P that should be given as guano to different soils.

A fault often observed in the thinnest and finest wrapper leaves is the presence of transparent patches resembling oil stains. Up to the present all attempts to obviate the fault by special (*e.g.* organic) manuring have been unsuccessful. The method of drying seems to have more influence, the stains appearing at the commencement of drying. Ripe leaves, which dry quickly, are less susceptible than unripe leaves.

The Botanical Department has shown by controlled drying with the aid of salts that slow or irregular drying favours the appearance of these stains. Apart from the impossibility of varying the drying process as applied in present practice, the fact that other qualities are harmed by rapid drying militates against the application of this knowledge.

Some tobacco varieties seem to be fairly immune to the appearance of oily stains.

*Slime disease.* — Another main line of research of the Agricultural Department concerns the control of slime disease (*Pseudomonas solanacearum*) by cultural means. In pot experiments control was obtained by treatment with gypsum, oilcake, and stabilized humus preparations, but field experiments, with some exceptions, have been unsuccessful. Large applications of well-rotted leaf-mould some weeks before planting were also ineffective.

Slime disease often begins in a root at considerable depth where it is impracticable to apply fertilizer. The uncultivated subsoil may also harbour the disease. No connexion has been found between the structure of the soil and the situation of infected roots.

It is known that the natural jungle-growth harbours the disease, although on a reduced scale, during the seven-year fallow period. The influence of different tree species on the incidence of the disease in the subsequent tobacco plantation has been investigated in a prolonged investigation of regrowth (see *Meded.*, Ser. 3, No. 9). The object is to find the kind of growth that will reduce the disease as much as possible and at the same time give a good-quality tobacco. It has long been known that *Mimosa invisa* controls slime disease, but it has the great disadvantage that tobacco grown after *Mimosa* is of inferior quality. The whole problem of slime sickness, and not only the quality of tobacco, requires investigation by field experiment. It is not sufficient to search for immune plants. The humus-producing and soil-improving properties of the regrowth are just as important as the susceptibility to disease of the plants of which it is composed. It should be noted that shortening the resting period on susceptible land increased the amount of slime disease in the tobacco. The field experiments, however, last from four to eight years. We are now trying to get results more quickly by letting the plants grow in seed-beds of soil infected with slime disease and determining after one year whether more or fewer diseased seedlings are produced.

It seems possible, by heavy doses of sulphur or of an alkaline fertilizer, to effect such a change in soil reaction that the slime disease in plantations and in seed-beds is greatly reduced or disappears, but this immediately and harmfully influences the growth of the tobacco.

*Field experiments.* — Statistical treatment of field experiments is not suitable for Sumatra tobacco nor, indeed, for any high-quality product, since a subjective assessment of quality cannot be expressed in figures. In order to get reliable results more quickly from field experiments the advantages and possibilities of modern methods are now being studied.

**Botanical Department** (Dr. VAN DER WEIJ):—

This department is engaged in physiological, phyto-pathological, and selection studies; the last are limited to selection for disease resistance.

Some recent investigations have concerned the

physiology of nutrition in water-cultures. Very well-developed plants are obtained in water-cultures in the open air when the nutrient solution (in 10-litre pots) is changed daily and aerated continuously; as far as we are aware normal plants have not hitherto been obtained in water-culture. With such cultures symptoms of deficiency of the ordinary essential elements N, P, K, Ca, Mg, S, and B in Sumatra tobacco were studied. Deficiencies of N, P, K, and B occur in practice. (See *Bull. D.P.S.*, Ser. 3, No. 44.)

*Plant diseases.* — Phyto-pathological work has included recent studies of various virus diseases, slime disease, and *Cercospora.*

Control measures against ordinary mosaic have been formulated as a result of extensive investigations (*Meded. D.P.S.*, Ser. 3, Nos. 6 and 11), and it is now possible practically to eliminate the disease which a few years ago was very serious. Primary cases in seed-beds and plantations usually originate from virus in the soil. Badly growing and roughly planted individuals are the most susceptible, and the soil type also affects incidence to a considerable extent. Thorough search for the first symptoms of the disease and direct removal of affected plants are the best ways of preventing infection by contact. The best disinfectant for use by workpeople is a trisodium-phosphate soap solution, but this form of control is of secondary importance. A beginning has been made with resistance-selection against mosaic by crossing with *Ambalema*. The Rotterdam B-virus may also infect tobacco plants from the soil (*Vlugschrift D.P.S.*, No. 61).

Another mosaic disease, formerly often confused with ordinary mosaic and known as *pseudo-mosaic*, does not derive from the soil; it has become important in recent years. It is not readily transmitted by contact and shows such similarity in its way of spreading through plantations to leaf-curl disease which is transmitted by *Bemisia*, that this insect is suspected of being the transmitter. The Entomological Department is, indeed, trying to establish what connexion exists.

In some years frog-eye disease (*Cercospora nicotianae*) causes great damage. Yellow copper oxide, either sprayed or dusted, checks the appearance of white spots and barn spots and is preferable to Bordeaux mixture in that it has no visible effect on the leaf. Unfortunately it may adversely affect the quality of the tobacco, presumably through absorption of traces of copper. Experiments have been made to determine whether very low concentrations can be used. It has been shown that *Cercospora* spores remain virulent for years in the soil of drying-sheds and in harvested tobacco-land. The sub-soil and seven-year fallow land contain few or no virulent spores. No success has attended efforts to isolate less spot-susceptible strains of Sumatra tobacco.

There seem to be greater chances of success in selecting strains less susceptible to slime sickness, the principal disease of Sumatra tobacco. Where tobacco is a quality-product this involves selection not only for disease resistance but also for quality. All foreign tobacco strains are more susceptible than Sumatra tobacco, presumably because in Sumatra, owing to the prevalence of slime disease, there has always been some degree of selection for resistance since tobacco-culture began. From old Sumatra stock several varieties have been selected which displayed high resistance on slime-sick soil, but produced inferior tobacco. From these progeny have been obtained by crossing that seem to possess increased resistance as well as other properties associated with good quality. They are not immune, but the mortality rate is lower, *e.g.*, 20 per cent. against 50 per cent. for ordinary tobacco. Whether this relative immunity persists or not remains to be seen when the produce of selection has been fully tried out in practice.

It is evident, however, that slime disease does not spread from plant to plant through a plantation, and that its patchy occurrence is the result of soil heterogeneity or of seed-bed infection. The disease begins mostly within 18 days after planting (*Meded.*, Ser. 3, No. 10).

**Entomological Department** (Dr. VAN DER LAAN):—

*Insect pests.* — Since Sumatra tobacco produces only wrapper leaf, every small hole caused by any of the many insects that attack the leaf results in an appreciable reduction in value. The chief pests are four caterpillars of the Noctuidae,[1] the capsid *Engitatus tenuis* Reut, and the aphid *Myzus persicae* Sulz. In the tropical climate development is rapid; one generation of *Plusia* is complete in three weeks, of the other caterpillars and of the capsid in a month, and of the aphid in only six days. There is no resting period where there is no marked dry period. During one tobacco plantation, lasting about five months, several generations may develop and often form serious plagues.

Possibilities of control are limited since the tobacco leaf is very sensitive to most chemicals, whilst other insecticides injure the market value of the produce by the formation of film on the leaves. Thus caterpillar damage should be reducible by careful spraying with 1 per cent. lead arsenate solution, but this is only practicable on the seed-bed or on the first-formed leaves in the field, *i.e.* on leaves that are not harvested.

The larger tobacco can be protected against *Heliothis* damage in the head only by a careful and sparse dusting with barium fluorsilicate (6–8 per cent.) or lead arsenate (5 per cent.) in the apex. Latterly only the first-named and less poisonous insecticide has been used. In order to get a similar effect a concentration of 8 per cent. (against 5 per cent. for lead arsenate) must be used, and the dusting should be repeated frequently as barium fluorsilicate does not adhere well. The effect is not improved by mixing with flour nor by adding Vatsol OS as adhesive. Cryolite seems practicable; calcium arsenate and Paris green cause too much burning. The contact insecticides derris and pyrethrum have an incomplete effect, as the caterpillars are not very sensitive to them. Chemical methods of control are unsatisfactory against *Plusia* and *Prodenia* since these caterpillars mostly lie underneath the old leaves where they cannot be dusted. These caterpillars and the egg heaps of *Prodenia* are in large measure removed by cheap native labour.

Even after the leaves have been plucked, caterpillars which are three or more days old go on feeding in the drying-sheds, but the younger ones do not. Attempts to kill these caterpillars by brief fumigation of the harvested leaves with HCN, ethylene oxide, ethylene sulphide, or "methallyl chloride" have failed owing to damage

[1] *Heliothis assulta* Guen, *H. armigera* F., *Plusia signeta* F., *Prodenia litura* L.

caused to the leaves, or because the fumigant was too impracticable (*Meded. D.P.S.*, Ser. 3, No. 5). Some help is given by dusting with derris, which, however, also damages the tobacco. The best check is to find and destroy the caterpillars before the leaves are hung up.

The source of infection is to be sought in the circumstance that the tobacco plantations are surrounded every year by temporarily abandoned land of former plantations. The chance of a plantation infecting a succeeding one is diminished by the complete removal of all tobacco at the end of the season. This is also the reason why the otherwise harmful *Phthorimaea heliopa* Low. does little damage under these conditions, as it lives exclusively off tobacco. An extensive investigation (*Meded. D.P.S.*, Ser. 3, No. 8) of the life habits of the caterpillars in fallow land showed that they live in certain types of weed vegetation when tobacco is not available. Removal of this vegetation before tobacco-planting time seems to be practicable and economic. As, however, the butterflies seem to have a flying range of several hundred metres, it is not sufficient to keep clear merely the immediate surroundings of the tobacco. Attention is now being paid to the possibility of introducing new parasites of the caterpillars. The *Prodenia*-egg parasite *Telenomus spodopterae* Dodd. has already been imported from Java, but it is not yet known whether it has maintained itself.

Since 1928 the leaf-louse *Myzus persicae* has been sprayed with an aqueous extract of derris root, specially prepared by us. This is now replaced by cheaper and more convenient derris powder, which before use is suspended in water so as to give 0·01 per cent. of rotenone. Much derris spoils the flavour of the tobacco.

Derris, especially for dusting, is also effective against the capsid *Engytatus tenuis* Reut., which bores into the leaf causing weak spots that grow into lesions. Such treatment, however, can only diminish, not suppress, this pest. Destruction by hand and treatment with pyrethrum and nicotine are ineffective. As in caterpillar control, it is desirable to look out for the host plants of this capsid and to keep them well away from tobacco (*Vlugschrift D.P.S.*, No. 68).

The transmission of pseudo-mosaic has been studied from the entomological point of view with much success. *Bemisia gossypiperda* seems to transmit the virus to tobacco from plants growing on the fallow, especially the Compositae *Eupatorium odoratum*, *Vernonia chinensis*, *Ageratum conyzoides*, *Synedrella nodiflora*, and the Verbenaceae *Stachytarpheta dichotoma*. Owing to neglect of afforestation, *Eupatorium* (symptoms difficult to detect, possibly a symptomless virus carrier) has been able to spread itself freely over several estates, and as a result damage from pseudo-mosaic has attained catastrophic proportions in places. This plant is now eradicated from the jungle. Killing *Bemisia* on the tobacco with contact insecticides, especially pyrethrum-talc dust, is certainly possible, but it causes practically no diminution of disease. Keeping *Bemisia* away from tobacco by means of a high fence is more effective, but this is still in the test stage. *Bemisiae* are caught from the air on sticky cloth 4½ metres high. It has been shown in practice that they are transported several hundred metres by wind, so that extermination of the plant from a narrow strip in the neighbourhood of the tobacco is not adequate. Attention is now being given to the introduction of new parasites of this insect (see *Vlugschrift D.P.S.*, No. 67).

Nematodes (*Heterodera marioni*) can be very efficiently controlled in seed-beds by fumigation with methallyl chloride, carbon bisulphide, or chloropicrin; the first-named is the cheapest. Seed-taking ants (*Solinopsis geminata*) are killed in the seed-bed by five days' dusting with derris (once daily after the last watering).

At the outbreak of the war the question was being discussed of how to protect tobacco from *Lasioderma* attack. It seemed probable that disinfection with $CS_2$ would somewhat spoil the flavour, and in order to prevent reinfection after a disinfection the baled tobacco is stored in an insect-free, well-aerated mosquito chamber. The beetles cannot, although their eggs and larvae can, get through the mosquito netting. For this reason the tobacco is nowhere allowed to touch the netting; larvae crawling over the floor are killed with derris scattered on it; larvae falling through the ceiling netting are caught on a sheet of derris-treated cotton. Many hygienic measures are taken to reduce the risk of infection before the tobacco is packed. The damage done by *Lasioderma* has been negligible, thanks to a very restricted use of fumigators.

The principal fumigator now used is the Shell product "Methallyl chloride," which affects the flavour of tobacco less than does carbon bisulphide, and is more convenient to use on account of its greater insecticidal effect. In the concentration employed it is non-inflammable, and the liquid itself can be made non-inflammable by mixing with 1¼ volumes of carbon tetrachloride. Other gases, prussic acid, chloropicrin, methyl bromide, ethylene oxide, were either too dear or did not thoroughly penetrate the closely packed tobacco bales.

Storage in the mountains of Sumatra does not prevent *Lasioderma* attack. *Lasioderma* is suffocated in the fermenting piles. An impenetrable packing material is useful, but is not completely permeable to air.

In stored tobacco the moth *Setomorpha rutella* sometimes occurs, but does little damage. *Ephestia elutella* is not found at Deli.

In order to guarantee that export tobacco is free from *Lasioderma* attack, control measures and the inspection of stored tobacco are kept in our hands (see *Meded.*, Ser. 3, No. 14).

Agrochemical Department (A. C. POLVLIET):—

*Soil survey.* — The extensive agrogeological mapping by Dr. DRUIF was completed in 1938. A reconnaissance map on a scale of 1:100,000 of the main soil types was prepared. The detailed map (1:5,000) of all soil varieties was nearly finished and only required continuation according to the same criteria as the completed parts. This represents a beautiful and fruitful scientific achievement, of great importance in the evaluation of tobacco soils. For example, all "red" soils are no longer treated alike, nor are (red) tertiary soils planted, for they produce poor tobacco.

*Chemical analysis.* — After two years' work based on the agrogeological map a beginning has been made with the collection of agrochemical data. The aim is to be able so to characterize soils by analysis that the results of fertilizer tests on any given soil will give indications of the fertilizer requirements of other soil varieties related thereto not only agrogeologically but also

chemically. We are now investigating which analytical methods are the most suitable, *i.e*, those which give the best agreement with the fertilizer requirements known from experience of the main soil types, and are the most sensitive to the normal fertilizer applications given to tobacco. We have thus come to approve the determination of citric-acid-soluble $P_2O_5$; carbonic-acid-soluble $P_2O_5$; $K_2O$ by Morgan's method (acetate buffer, *p*H 4·8); $NO_3$ by Morgan's or Harper's method; and *p*H by the glass electrode.

Analyses of reforested soils which have been under a definite cover for several years have shown that the favourable influence exerted on tobacco by a luxuriant forest-growth is attributable to an increase in P and K. The removal of green material from the forest is harmful, whereas its introduction is beneficial.

We have also investigated whether the composition of tobacco-leaf ash is influenced by fertilizer treatment, in which case ash analyses could be used to give indications of fertilizer requirement. It appears that such an influence does exist, but is by no means simple. An SK application, for example, though it produces better growth, seldom causes an increase in the percentage of $K_2O$ and may cause an increase in $SO_3$, as well as influencing the content of N and other elements. A rational use of ash analyses in determining fertilizer requirements will be possible only after much experience has been gained in interpreting the figures. The different P and K requirements of the different soil types are reflected in corresponding differences in ash analyses, but here the ash analyses are much less helpful than they would be in comparing less dissimilar soils. Potash-deficiency is sharply reflected in ash-composition.

An orientated investigation of micro-elements in tobacco and soil was undertaken by us in Holland with the aid of semi-quantitative spectrographic analysis. The tobacco of black soils, which have high P and K requirements, seems to contain relatively little Mn, Zn, Sr, Ba, Ga, and Na. The micro-elements V, Mo, Cu, Co, Cd, Ni, Mn, Al, Ba, Ti, Zr, Ce, Li, Cr, Zn, Pb, and Ga have now been detected in Deli tobacco, besides W, Se, Y, and Cs in the soil.

The Agrochemical Department carries out many kinds of analytical work as well as research in connexion with the control of fertilizers, insecticides, &c.

# TAGEBUCH EINER REISE IN NORD-SUMATRA

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Das Gouvernement Atjeh im Norden der holländisch-indischen Insel Sumatra nimmt in geographischer und geschichtlicher Hinsicht eine Sonderstellung ein. Das Land ist gebirgig, doch während in den Hochebenen der Westküste und des Batakergebietes der Sawareisbau zu hoher Blüte gelangt ist und die kunstvoll bewässerten Felder der Landschaft ein fruchtbares Aussehen verleihen, beherrscht in den Bergen Atjehs, den sog. Gajolanden, das Blang das Landschaftsbild, welches als weite, in die Urwälder eingestreute Lalanggrassteppe mit charakteristischen Föhrenbeständen an kühlere Zonen erinnert. Der Blangboden ist meist sandig und unfruchtbar, und nur an jenen Stellen, wo der tertiäre Sandstein von jungen vulkanischen Decken überlagert wird, oder auf frischen Rodungsflächen gedeihen Kaffee und andere anspruchsvolle Nutzpflanzen. Die dünne Besiedlung und die große Entfernung von europäischen Siedlungszentren erhielten die Tierwelt bis heute in überraschender Ursprünglichkeit, und das Land gilt mit Recht als eines der wildreichsten Gebiete von Insulinde.

Atjeh hat der holländischen Kolonisation beträchtliche Schwierigkeiten bereitet: jahrelange Zurückhaltung und Passivität auf Seite der Regierung, ferner die schwere Zugänglichkeit des Geländes und der Unabhängigkeitssinn der Bevölkerung führten zu einer Aufschiebung entscheidender Aktionen. Die Atjeher gehören der malaiischen und vormalaiischen Rasse an; sie sind strenggläubige Mohammedaner, und es trat zum jahrzehntelang genährten Haß gegen den Kolonisator religiöser Fanatismus, welcher in sehr blutigen kriegerischen Auseinandersetzungen endete. Die junge Generation sieht jedoch keine Ursache mehr, sich der vorbildlichen und humanen Führung durch die holländisch-indische Regierung zu widersetzen und hat deshalb bis zum Ausbruch der gegenwärtigen Krise an der gedeihlichen Entwicklung des ganzen Kolonialreiches regen Anteil genommen.

Sumatra samt den übrigen Inseln der holländischen Kolonie bietet unerschöpfliche Möglichkeiten für Studienreisen und wissenschaftliche Expeditionen. Daneben ist es dank der Großzügigkeit der Regierung auch zahlreichen Nicht-Holländern möglich, sich hier dauernd zu betätigen. Der Schweizerverein Deli auf Sumatra zählt seit seinem Bestehen über 450 Mitglieder, welche als Pflanzer, Biologen, Ärzte, Geologen, Techniker und Topographen am wirtschaftlichen und kulturellen Aufstieg der Insel mitarbeiteten.

26. Juni 1936. Mit vielstimmigem Getöse aus der Richtung der Nachbarpflanzung Negaga kündigt sich der Nachmittagsregen an; es kommt Bewegung in die schwüle Luft meines Laboratoriums, und die Wedel der alten Ölpalmen über der Straße knistern. JANSEN, mein brauner Assistent, schiebt sein Fahrrad unter Dach und eilt dann nach dem Hauptgebäude, um die Post abzuholen. Ein Brief von Herrn A. BÖHMER aus Medan liegt bei. Er schreibt, er habe sich bei einem Bekannten des nähern über Atjeh erkundigt, wir hätten dort oben im Norden der Insel alles, was unser Herz begehre: ein bequemes Ausgangsquartier, zuverlässige Führung durch Inländer und großen Wildreichtum. Ich sage zu: am 2. Juli werde ich mit meinem alten Fordwagen von Goenoeng Malajoe[1] nach Medan fahren, um ihn abzuholen; BÖHMER wird malen, und ich

* Nachdruck, mit freundlicher Erlaubniss, aus der *Schweiz. Zeitschrift für Forstwesen* 93:33–46 (1942).

[1] Goenoeng Malajoe usw.: holländische Schreibweise, sprich Gunung Malaju.

werde mich biologischen Studien widmen.

2. Juli. Die Entfernung Goenoeng Malajoe — Medan beträgt 200 km; ein großer Teil der Strecke entfällt auf die endlosen Kautschukwälder, welche uns als eintönige Mauer längs der Straße jede Aussicht verwehren. Die kostbare Kautschukmilch fließt aus oberflächlichen, schräg in der Stammrinde angebrachten Schnittwunden und sammelt sich in kleinen Porzellan- oder Aluminiumtassen. Hie und da sind kleine Fruchtgärten der Malaien eingestreut mit Kokospalmen und breitblättrigen Bananenstauden. Mancher Inländer hat, als der Gummi hoch im Preis stand, die großen Plantagengesellschaften im kleinen nachgeahmt und auf seinem Grundstück Kautschukbäume gepflanzt; Tausende sind diesem Beispiel gefolgt und bilden heute für den europäischen Pflanzer eine fühlbare Konkurrenz. Der Kautschukbaum *Hevea brasiliensis* stammt aus Südamerika und bedeckt heute in laubwaldartigen Beständen große Flächen auf Sumatra und der malaiischen Halbinsel. Es ist das Verdienst unseres Landsmannes Dr. C. HEUSSER, welcher in einer Versuchsanstalt an der Ostküste tätig war, die Produktivität des Kautschukbaumes durch Auslese und Zucht wesentlich gesteigert zu haben.

Medan steht auf Tabakland, das Gelände wird offener und heller. Ich biege in den Serdangweg ein und treffe BÖHMER auf der Veranda seines kleinen luftigen Heims. Wir verbringen einen angenehmen Nachmittag mit Pläneschmieden und Vorbereiten. BÖHMER erzählt mir gegen Abend seine Erlebnisse als Pflanzer in Guatemala und als Landvermesser in den Urwäldern von Südsumatra.

3. Juli. Noch ist es dunkel, und ein kühler Wind weht durch den Garten; wir binden unsere großen vollgestopften Blechbüchsen und die Zeltlast auf den Gepäckträger und fahren los. Die Straßen von Medan sind noch leer. Zwischen der Stadt und Bindjei breiten sich die riesigen Tabakfelder aus. Der fruchtbarste Boden wird hier dieser Luxuskultur geopfert, und je sechs Jahre müssen die Felder vor jeder Neubepflanzung brachliegen, damit wieder der echte Delitabak aus dem Boden wächst. Vor Tandjong Poera zewigt eine Straße nach der Pflanzung Tjinta Radja ab, wo von Schweizerpflanzern der bestbezahlte Delitabak gezogen wird. In Pangkalan Brandan sieht man aus der Ferne die Schornsteine der großen Erdölraffinerien der Batavschen Petroleum-Gesellschaft, welcher Ölquellen auf Java, Borneo, Neu-Guinea, Mexiko und Venezuela unterstehen. Es finden sich zahlreiche Bohrstellen, deren Kosten sich auf mehrere 100 000 Gulden belaufen können, längs der Küste in den Mangrovesümpfen und mitten im Urwald in der Nähe der Berge. Das Öl tritt stellenweise unter großem Druck heraus und muß oft gegen 100 km weit in mehrfachen Röhrensystemen abgeleitet werden. Auch Gaseruptionen sind nicht selten, die als hohe leuchtende Dauerfeuer im Wald drin weitherum sichtbar sind. Die Gesellschaft besitzt eigene Asphaltstraßen und private Polizei zur Bewachung der Anlagen; Feld- und Fabrikarbeiten werden aus Konkurrenzgründen streng geheimgehalten.

4. Juli. Der Weg von Idi nach Bireun führt durch ausgedehnte Kokos- und Pinangwälder, alles Inländerkulturen. Aus einem großen seichten Stausee ragen Inseln, die mit baumhohem Bambus bewachsen sind, und die Wasserfläche ist mit Seerosen und Lotos bedeckt. In Bireun, früher ein bedeutendes militärisches Aktionszentrum, kaufen wir Reis und Früchte, dann zweigen wir gegen Süden ab und steigen auf der Takengonstraße nach unserem Bestimmungsort Blang Rakal hinauf, wo BÖHMER einen Kapokpflanzer kennt. Weideland erscheint, und auf dem Bergrücken erreichen wir die ersten Föhrenbestände.

Der Kapokpflanzer war früher Assistent in einer Kautschukfabrik. Lange Zeit arbeitslos, verfiel er auf die sonderbare Idee, hier auf einer trostlosen unfruchtbaren Bergweide Kapok zu kultivieren. Etwa 40 Hektare sind schon bepflanzt, die jungen Bäumchen stehen mitten im ausgedörrten dürftigen Gras drin, und die Inländer, die sog. Gajo schütteln den Kopf und können nicht verstehen, warum und durch welchen Zauber der weiße Herr auf diesem ausgewaschenen Boden überhaupt Kapokbäume am Leben halten kann. Er arbeitet nämlich mit teurem Kunstdünger. Leider hat er gar keine Pflanzererfahrung, und sein Unternehmen ist wahrscheinlich zum Scheitern verurteilt, weil sich die intensive Düngung auf die Dauer kaum lohnen wird und die junge Pflanzung infolge der leichten Entzündlichkeit des trockenen Grasunterwuchses ständig bedroht ist. Die jahrelange Abgeschiedenheit von seinesgleichen und die stete Angst um seine Kapokfelder erzeugen in ihm eine zweifelhafte Verfassung und übertriebene Furcht vor den Gajo.

Am Abend stellt uns der Kapokpflanzer ausgezeichneten aromatischen Urwaldhonig auf, den die Gajo von hohen Bäumen heruntergeholt haben, und ist uns auch behilflich beim Aufstellen unseres Reiseplanes. Es ist unser Ziel, einen möglichst unberührten Platz zu finden, wo Hirsche, Tiger, und, wenn möglich, Elefanten zu beobachten sind.

5. Juli. BEDOEL, der Haarschneider von Blang Rakal, ist nirgends zu finden. Seine Frau sagt, er sei mit einigen Freunden an den Peusangan hinunter fischen gegangen. Der Kapokpflanzer meint, dieser Mann sei zuverlässig und ein guter Träger. Wir sehen uns nach zwei weitern Leuten um. Die Gajo AMANRIAM und AMANSALE sind bereit, mitzukommen, unter der Bedingung, pro Tag 70 Cent und für jeden erlegten Hirsch zwei Gulden Belohnung zu erhalten. Wir haben durch diese Abmachung die Garantie, in wildreiche Gegenden geführt zu werden.

Nach einer kurzen Wanderung erreichen wir den Peusanganfluß, wo wir direkt neben einer Gajo-Jagdhütte unser Zelt aufschlagen. Ein starkes Rotanseil führt über das reißende Wasser, und zu beiden Seiten dieser primitiven Brücke stehen kleine Unterstände aus Blättern der Serdangpalme mit mehreren Feuerstellen. Eine Jagdgesellschaft scheint sich am gegenüberliegenden Ufer zu betätigen. Hie und da hören wir Rufe und sehen auf dem Steilufer einzelne Leute aus dem Wald treten und wieder verschwinden. Die Gajo sind leidenschaftliche Jäger, doch ist ihnen der Gebrauch von Feuerwaffen in Anbetracht ihrer jahrelangen Widersetzlichkeit gegenüber der Kolonialregierung verboten worden. Mit Speer und Messer, unterstützt von gutgehaltenen Hunden, unternehmen sie mit Vorliebe Treibjagden auf den großen Rusahirsch. Gegen Abend erscheinen drüben vier Gajo. Sie binden sich ihre Bündel auf den Kopf und hangeln, jeder einen Speer in der Hand, am Rotanseil zu uns

herüber; in der Flußmitte schäumt das Wasser bis an ihren Hals hinauf. Später folgt eine zweite Abteilung mit einer großen Hundemeute; diese Leute schaffen einen zerlegten Hirsch über den Fluß, dann versammeln sie sich alle unter dem Blätterdach und machen Feuer. Doch ein Teil der Meute steht immer noch winselnd am jenseitigen Ufer und wagt sich nicht in das reißende Wasser. Ein junger Gajo ruft und lockt die Tiere, sie arbeiten sich schließlich durch die Strömung und werden weit abgetrieben, bis sie unser Ufer erreichen können, dann belagern sie eine ausgehöhlte Felsplatte, wo jeder der Reihe nach eine Handvoll Wasserreis erhält. BÖHMER und ich haben unser Zelt schon gemütlich eingerichtet und das feinmaschige weiße Mückennetz oder Klamboe über dem weichen Blätterlager ausgespannt. JANSEN kocht und stellt dampfenden Reis mit Tee auf. Dann haben wir Zeit, unsere Nachbarn näher kennenzulernen. Die Jungen sind nun damit beschäftigt, das Fleisch zu zerschneiden und, in kleinen Stücken an hölzerne Bratspieße zu stecken, während sich die Väter von den Strapazen erholen. Die ältere Generation ist uns Europäern gegenüber sehr verschlossen, einzelne unter ihnen haben etwas Ungemütliches und Seeräuberhaftes in ihren Zügen, ganz im Gegensatz zu den jüngern, welche sich wie gewöhnliche Malaien oder Javanen ausfragen lassen und sich für unsere Reise interessieren.

Nach Sonnenuntergang knien einige Gajo am Fluß drunten; sie verbeugen sich tief und wiederholt gegen Westen und beten als Mohammedaner auch hier mitten im sumatranischen Urwald gegen Mekka. Die Jäger legen sich erst spät zur Ruhe, sie sitzen noch lange Zeit beim Feuer, braten und essen. Einer unter ihnen singt zum Schluß ein monotones, beinahe sehnsüchtiges Lied. Dann verstummt das Gemurmel und nur das Rauschen des Peusangan, vermischt mit wilder Insektenmusik, dringt durch Zelt und Klamboe.

6. Juli. Wir warten bis AMANRIAM, BEDOEL und AMANSALE mit dem Rest der Lasten vom Blang Rakal zuruckgekehrt sind und marschieren dann flußabwärts bis zu einer ehemaligen Jagdhütte eines holländischen Beamten, wo der Fluß sehr breit und daher leicht zu durchwaten ist. JANSEN wird beinahe von der Strömung umgerissen, und BEDOEL muß ihm zu Hilfe eilen. Am andern Ufer finden wir eine kleine Schwefelquelle und zahlreiche Hirschspuren im Schlamm. Wir bauen hier unser zweites Lager und streifen in der Umgebung, um zu sammeln und zu beobachten.

7. Juli. Der Aufstieg auf den ehemaligen Militärpatrouillenpfaden ist anfangs sehr steil, und die Gajo keuchen unter ihren schweren Lasten. Wir gehen immer in dichtem Urwald ohne jede Aussicht und Orientierungsmöglichkeit und überschreiten mehrere kleine Bäche. Das Wasser ist klar, und wir trinken es oft ungekocht, was drunten im Tiefland nicht empfehlenswert wäre. An manchen Stellen wimmelt es von kleinen Fischen, und während einer Stundenrast holt sich BEDOEL sein Abendessen aus dem Wasser. Er steckt gekochte Reiskörner an einen kleinen Angelhaken und taucht sie ins Wasser; die Fische sind durch etwas Reis, welchen er neben sich in den Bach geworfen hat, angelockt worden, und nun kann er mit seinem Köder einen nach dem andern herausziehen, erst nach dem vierundzwanzigsten Fang werden die Fische mißtrauisch und beachten weder frei umherschwimmende noch angesteckte Reiskörner.

Wir treten aus dem dumpfen Baumlabyrinth auf die offene Grasfläche des Blang Broesa, die mitten in einer hügeligen Landschaft drin eingebettet liegt. Breite Elefantenpfade ziehen sich durch den oft mannshohen Lalang und erleichtern unser Vorwärtskommen ganz beträchtlich. In einer bewaldeten Mulde hoffen wir günstige Wasserstellen zu finden, weil straßenbreite ebengetretene Spuren hinabführen. Der Bach im Wald drin ist in der Tat von den schweren Vierbeinern zu einem rechteckigen Becken ausgetreten worden, und eine richtige Treppe, deren Stufen genau mit der Breite eines Elefantenfußes übereinstimmen, führt zu diesem idealen Badeweiher. Hier bauen wir unser Zelt, diesmal etwas sorgfältiger als gewöhnlich, denn es soll mehrere Tage aushalten. Die Seitenwände werden diesmal mit Querhölzern und Blättern verschlossen, und nur ein kleiner Eingang bleibt frei. Den Boden polstern wir mit einer dicken Lage Lalanggras und legen Decken darüber. Nachts wird zudem das Klamboe aufgehängt. In diesem saubern weißen Mückennetz wächst nach kurzem Aufenthalt die beruhigende und schlafbringende Illusion des Daheim- und Gesichertseins. Die Gefahr, überfallen zu werden, ist tatsächlich auch gering, weil ein sumatranischer Tiger in der Regel kein Bedürfnis nach Menschenfleisch hat. Auch sagt ihm sein Instinkt, daß ein Überfall auf Zweibeiner ihn in kritische Situationen führen könnte, denen sein Katzengehirn nicht gewachsen wäre; so läßt er es lieber sein, die eigene Haut aufs Spiel zu setzen. Von dieser Geschmacksspezialisierung des Tigers und seiner nicht immer berechtigten Unsicherheit im Auftreten profitiert jeder, der, wie wir, in der Wildnis kampiert. Mit großem Geschick bauen die Gajo ihr eigenes Regendach: zuerst einen schräg gestellten Rahmen aus jungen Stämmchen, in welchen Blätter und Grasbüschel eingeflochten werden, dann seitlich Wände aus ähnlichem Material; vorn bleibt die Hütte offen. Auf beiden Seiten werden Feuer angezündet.

8. Juli. Wir unternehmen einen Rekognoszierungsmarsch auf dem großen Blangrücken. Elefantenspuren sind 6 bis 8 km weit zu verfolgen. Große Flächen des Blangs sind von Einheimischen angezündet worden, und das Hellgelb des dürren Lalangs wird überall von braunen und rußschwarzen Brandstellen unterbrochen; Rauchfetzen liegen an den Hängen, und wenn der Wind stark weht, kriegt man Asche in die Augen und Lungen. Im Südwesten erscheinen einzelne Gajohütten, und in der Nähe weiden Büffel in den feuchten, mit saftigem Gras bewachsenen Talmulden. Wir setzen uns auf eine aussichtsreiche Kuppe und bitten BEDOEL, uns einiges über dieses Land zu erzählen:

Vor 50 Jahren lebten etwa 300 Leute auf Blang Broesa, heute sind es nur noch 20 bis 30; viele der frühern Bewohner waren für die Regierung zu gefährlich und wurden während den Atjehkriegen von den Truppen zwangsweise nach leichter zugänglichen Orten im Tiefland versetzt. Doch viele verstanden es, sich den Strafexpeditionen durch Flucht in die Wälder zu entziehen, und die Aktionen mußten häufig wiederholt werden. Auch heute ziehen hie und da noch Kontrollpatrouillen durch dieses Gebiet. Früher waren die Elefanten auf Blang Broesa sehr zahlreich und bildeten große Herden, heute trifft man sie meist nur noch in Gruppen von 8 bis 12 Stück. Etwa 200 Wasserbüffel oder Karbauen werden

hier des Fleisches wegen gehalten und zum größten Teil im Tiefland verkauft. Sie liefern kaum einen Liter Milch im Tag, die direkt zu Butter verarbeitet und eingekocht wird. Die Karbauenhüter erhalten nach einem Jahr von jedem Besitzer ein Tier als Entschädigung, zusammen etwa 10—12 Stück. Für einen Karbau zahlt man hier oben 30—40 Gulden, für Pferde 10—15, Buckelochsen 25—30, Jagdhunde 25—35 und für Hühner 10 Cent.

Abends geht BÖHMER auf die Jagd und bringt einen Hirsch zum Lager mit Kopfschuß. Doch ist mein guter Freund sehr aufgeregt, da er bei weitem nicht das abgehärtete Herz eines Berufsjägers besitzt, und es tut ihm nachträglich leid, auf das schöne Tier geschossen zu haben. Ich zerlege den Hirsch zusammen mit den Gajo; der größte Teil wird fein zerschnitten und soll nach Malaienart zu Deng-deng, d. h. Trockenfleisch, verarbeitet werden, während der Rest später als Tigerköder dienen soll.

9. Juli. BÖHMER unternimmt eine Exkursion nach der nächstgelegenen Gajosiedlung und bringt die neuesten Nachrichten: Vor sechs Tagen, um elf Uhr vormittags, wurde direkt beim Kampong, auf dem den Wohnungen gegenüberliegenden Steilufer des Broesabaches, ein Karbauenkalb von einem Tiger angefallen. Die Kampongbewohner konnten zusehen, Rufen und Schreien nützte jedoch nichts. Der erste Ansprung mißlang, weil der Tiger auf dem steilen Abhang schlechten Halt hatte und ausrutschte. Unterdessen wurde das Muttertier aufmerksam und ging direkt auf den Angreifer los, der sich schließlich zurückziehen mußte. Karbauen, besonders junge, werden ziemlich häufig von Tigern angefallen. Kein Gajo wagt es, allein durch das Blang zu gehen; immer ziehen sie in kleinen Gruppen und mit Speeren bewaffnet aus. Vor zehn Tagen bummelten Elefanten über das Blang Broesa, sie sollen heute noch etwa drei Stunden vom Kampong weg anzutreffen sein.

Abends geht BÖHMER wieder auf Hirsche aus und hat das Glück, fünf ausgewachsene stattliche Tiere aus der Nähe beobachten zu können. Er kann ihnen etwa eine Viertelstunde lang zuschauen; sie sehen ihn, ohne wegzulaufen, weil sie noch nicht wissen, daß ein Mensch auch über größere Entfernungen gefährlich sein kann. Natürlich schießt er diesmal nicht.

Ich gehe mit BEDOEL auf die Gidjangjagd. Der Gidjanghirsch hat etwa die Größe unseres Rehs und ist neben dem viel größeren Rusahirsch in Atjeh häufig. Wir benützen eine Gidjangflöte aus Bambus, mit welcher man bei einiger Geschicklichkeit die Locktöne des Weibchens hervorbringt. BEDOEL erzählt mir, daß er schon zusehen konnte, wie ein Hirschmännchen blindlings auf den Flötenden zurannte und leicht gespeert werden konnte. Nach Regen ist das Pfeifen auf der Flöte gefährlich, weil da leicht Tiger angelockt werden, die dann ebenfalls sehr kurzen Prozeß machen. Wir stellen uns vorsichtshalber zwischen die hohen Bretterwurzeln eines knorrigen Baumes und flöten mit großer Ausdauer, leider ohne Erfolg; es scheint sich kein liebeskranker Gidjangjunggeselle in der Nähe aufzuhalten, obwohl wir viele Spuren finden können.

Auf der Nordseite unseres Badebaches bildet der Waldboden eine sanfte Erhebung. Dahinter, in etwa 80 Meter Entfernung vom Zelt, ist der unverwertete Teil unseres Hirsches als Tigerköder ausgelegt worden. Etwa 15 Meter vom Kadaver haben die Gajo zwischen drei Baumstämmchen in 5 Meter Höhe eine Plattform errichtet; eine weitsprossige Leiter führt hinauf. BÖHMER ist auf seinem Ausflug zum Kampong gefallen und hat eine Rippe gebrochen; auch riecht der Köder heute noch zu wenig, und es ist unwahrscheinlich, daß schon diese Nacht ein Tiger angelockt wird. BÖHMER will daher im Zelt bleiben und schlafen, während ich um sieben Uhr nach dem Stand aufbreche, mit AMANRIAM als Begleiter. Die Kopfjagdlampe ist nicht immer ganz zuverlässig, und ich nehme als Reserve noch die große Handlampe mit. BÖHMER versichert mir, sie für diese Nacht im Lager gut entbehren zu können, zum Schlafen brauche er sie nicht, und wenn er unbedingt Licht haben müsse, so brenne stets ein großes Feuer vor dem Zelt.

Ich richte mich auf den Bäumen droben so gemütlich als möglich ein, hülle mich in eine leichte Wolldecke als Schutz gegen Mückenüberfälle, lege meinen Karabiner schußbereit neben mich und warte. Die Nacht ist sehr dunkel. Leuchtkäfer glühen als kleine sternschnuppenartige Lichtpunkte auf, schießen in geraden Bahnen durch das Gewirr von Ästen und Blättermassen oder beschreiben merkwürdige Spiralen und Kreise. Mein Gehör arbeitet angestrengt, um wenn möglich aus dem Summen, Zirpen und Quaken Laute herauszusieben, die mit dumpfen Schritten oder mit Tigerknurren Ähnlichkeit haben. Nichts ereignet sich, und AMANRIAM dreht sich schon in eine bequemere Lage, daß das mit Rotanseilen zusammengebundene Gerüst leise knarrt. Plötzlich tönt ein Schrei vom Lager her, und nach einer Weile hören wir BÖHMER angestrengt rufen: «Kommt her! — Der Tiger ist hier! — kommt schnell!» Ich antworte, mache Licht und erkläre AMANRIAM rasch die Situation. Natürlich ist er nicht begeistert. Mein eingeschlafenes Bein schleudere ich ein paarmal an den Baumstamm, daß die Rinde wegfliegt, und klettere dann hinunter, eher aus Pflicht, als mit großem Interesse an der Sache, denn erst jetzt beim Abstieg kommt mir die Tigersicherheit des Standes voll zum Bewußtsein. Wir marschieren vorsichtig und nach allen Seiten leuchtend zum Zelt. Die ganze Gesellschaft sitzt zusammengedrängt unter dem Gajodach, BÖHMER in der Mitte, den Mauser schußbereit gegen den Waldrand gerichtet. Ich will noch die Umgebung des Lagerplatzes ableuchten, BÖHMER läßt mir jedoch keine Ruhe und empfiehlt mir, so rasch wie möglich zu ihm unter Dach zu kommen. Es herrscht Aufregung unter den sonst gewiß nicht furchtsamen Gajo.

Schon um acht Uhr scheint ein Tiger um die Hütte geschlichen zu sein, die Gajo hörten ihn knurren, und BEDOELS Hund verkroch sich und winselte. Dann erschien er ein zweites Mal eine Stunde später, BÖHMER wurde geweckt, und alle setzten sich zusammen in die Gajohütte. Der Tiger ging nicht weg, sondern strich leise und ununterbrochen knurrend ums Lager herum, einmal sogar direkt auf die Hütte zu, und alle konnten auf sechs bis acht Meter Entfernung die Fratze sehen. Er schien angriffslustig zu sein, BÖHMER wollte noch rechtzeitig schießen, doch konnte er bei der schlechten Beleuchtung das Visier und Korn kaum sehen; er hatte keine Jagdlampe und sah sich deshalb gezwungen, mich zu rufen.

Wir warten noch eine Weile erfolglos auf den Tiger, schlüpfen dann in unser Zelt und schlafen

alsbald ein, nachdem wir uns ernsthaft vorgenommen haben, in Zukunft unsern großen Vorrat an feingeschnittenem Trockenfleisch nie mehr nachts neben dem Zelt ausgebreitet liegen zu lassen. Zweifellos haben diese Deng-deng den Tiger angelockt und mit ihrem verhältnismäßig intensiven Geruch einen großen Kadaver vorgetäuscht.

10. Juli. Den ganzen Tag arbeite ich wieder auf dem abgebrannten Hügel oberhalb unseres Lagers. Von hier überblickt man das ganze Blang Broesa und darüber hinaus das dichtbewaldete Si-Top-Top-Gebirge; in jener Gegend haust das Sumatranashorn, welches mit seiner ungestümen Angriffslust schon manchen Jäger in Verlegenheit gebracht hat. Der Waldpelz, welcher die umliegenden Höhenzüge und Kuppen überzieht, ist im Vordergrund gleichsam wegrasiert, und gelbgrünes Lalanggras ersetzt die reiche Vegetation des Urwaldes. Über die Entstehung dieser Blanglandschaft sind nur wenig Angaben erhältlich. Wahrscheinlich handelt es sich um ehemalige, zum Teil sehr alte Siedlungsgebiete, in welchen der Wald dem Ladangfeldbau weichen mußte. Die Armut und Trockenheit des sandigen Tertiär-Untergrundes erforderte eine fortschreitende Rodung, und auf den verlassenen Feldern nahm nach kurzer Zeit das anspruchslose Ladanggras überhand. Diese Entwicklung läßt sich auch heute noch an einigen bewohnten Randstellen des Blang Broesa verfolgen. Der Wald ist längs der Blanggrenze ohne jede vermittelnde Übergangszone scharf abgeschnitten, nur in feuchten Mulden hat er allmählich wieder Fuß fassen können. Die Entwaldung ist auf dieser sandigen und trockenen Hochfläche irreversibel, ganz im Gegensatz zu manchen fruchtbaren Gebieten der feuchtheißen Tiefebene, wo der Regenwald nach kurzem Vorpostengefecht verlassenes Kulturland wieder in Besitz nimmt.

Das Blang ist sehr tierarm, verglichen mit dem üppigen und überreichen Bergwald. An der Waldgrenze stoßen zwei strukturell völlig verschiedene Biocoenosen aufeinander, die unter gegensätzlichen mikroklimatischen Bedingungen stehen und nur sehr wenige gemeinsame Arten aufweisen. Im Blang finden sich unter den Insekten einige morphologisch und biologisch sehr merkwürdige Typen. Eine Diptere, *Diopsis indica*, trägt lange Stielaugen und sieht einer Blattwanze ähnlich, bei einer andern Fliege, einer Vertreterin der Celyphiden erreicht das sonst unscheinbare Schildchen des Brustabschnittes gewaltige Dimensionen, bedeckt den ganzen Hinterleib samt den beiden Flügeln und täuscht mit seiner metallblauen Farbe die Flügeldecken eines Blattkäfers vor. Eine Ameise (*Cremastogaster*) baut hohe Turmnester mit zahlreichen horizontalen Etagen, eine andere (*Diacamma*) schornsteinförmige Nestausgänge. Die hochspezialisierten Erdbauten der Ameisen, welche ganz auf die Umgebung abgestimmt sind und im Plantagengebiet der Ostküste nicht auftreten, lassen auf ein bedeutendes Alter des Atjeh-Blangs schließen. Eine weitere Eigentümlichkeit der Blanglandschaft sind die zerstreuten Föhrenwäldchen (*Pinus mercusii*). Diese Art findet sich nur an wenigen Stellen Sumatras und dann wieder in Höhenlagen Hinterindiens.

11. Juli. Morgens um sieben Uhr stehe ich im Elefantentrog am Bach drunten und gieße mir mit einer Biskuitschachtel kühles Wasser über den Rücken. Unterdessen sonnt sich ein prächtiges Tigerpaar auf dem Hügel über unserem Lager in etwa hundertfünfzig Meter Entfernung. Das männliche Tier sitzt aufgerichtet und betrachtet die Umgebung, dann und wann unser Zelt mit einem gleichgültigen Blick streifend; das Weibchen liegt ruhig vor ihm auf den rußigen Lalangstoppeln. Die Leute sind dermaßen in den Anblick dieses Bildes vertieft, daß niemand daran denkt, mich zu rufen, und wie ich zum Lager zurückkehre, sind die Tiger schon gegen den Wald hin abgezogen.

Nach diesem Ereignis marschieren wir mit BEDOEL und AMANRIAM ab, um das südöstliche Gebiet des Blangs kennenzulernen und wenn möglich im Kampong neuen Proviant zu fassen. BÖHMER will in einem Föhrenwäldchen malen. Ich unternehme mit AMANRIAM einen Eilmarsch nach dem Hauptkampong, den wir nach etwa einer Stunde erreichen. Wir klettern über den Holzzaun, welcher die ersten Hütten umschließt, und erkundigen uns nach dem Häuptling, dem Kapala Kampong. Einige Frauen mit Säuglingen und nackten, goldbehangenen Reisbauchkindern hocken vor den Leitern, welche an den leichten Pfahlbauten lehnen. Der Kapala sei momentan am Fluß drunten, heißt es. Wir warten etwa eine halbe Stunde, dann erscheint der Häuptling, mir zu Ehren, in einem zerknitterten, jedoch ordentlichen weißen Galaanzug mit goldenen Kragenknöpfen. Es ist schon recht spät, und ich frage ihn daher gleich ohne lange Einleitung, ob ich hier Früchte oder sonst etwas Genießbares kaufen könne. Ich habe damit bewußt den Adat, die übliche Volkssitte, die in derartigen Fällen eine lange plauderhafte Vorbereitung verlangt, verletzt und stoße nun auf großen Widerstand. Nichts, gar nichts sei vorhanden, er bedaure sehr, nicht aushelfen zu können, die Ananas seien noch nicht reif, und Bananen gebe es diesen Monat überhaupt keine. Ich zeige ihm schließlich einige Bananenstauden neben seiner Hütte, die lange goldgelbe Früchte tragen, doch er lügt mit großer Seelenruhe weiter, diese Sorte könne noch nicht gepflückt werden. AMANRIAM scheint die europäische Ungeduld zu kennen und hat einen solchen Schiffbruch vorausgeahnt, denn schon lange bevor wir den Kampong erreicht hatten, hat er mich gebeten, die Verhandlung allein führen zu dürfen. Ich erteile ihm daher das Wort, um den Kapala über unsere freundlichen und harmlosen Absichten ausführlich aufzuklären und seine Neugier zu befriedigen. Unterdessen lasse ich mir ein dickes Zuckerrohr aus dem Garten holen, um meine Zeit mit Schaben und Kauen totzuschlagen. Nach einer halben Stunde scheint der Häuptling schon soweit orientiert zu sein, daß ich einen zweiten Versuch, Proviant zu erhalten, wagen darf. Einige der umstehenden Frauen werden weggeschickt, und innerhalb der nächsten Stunde erscheinen Zuckerrohr, Ananas, wieder Zuckerrohr, zwei grüne Kokosnüsse, ein Bündel Obiwurzeln, einige Bananen und zum Schluß wieder eine Ananas.

Mit einbrechender Dunkelheit erreichen wir unser Lager. Ich genieße rasch etwas Reis mit Kokoswasser und steige darauf mit BÖHMER auf den Tigerstand. Das Aas riecht schon fürchterlich. Wir richten unsere Gewehre direkt auf den Köder und brauchen nur Licht zu machen und zu schießen, sobald sich ein Tiger an das Fleisch heranwagen sollte. Etwa um neun Uhr hören wir dumpfe schwere Schritte vom Zelt her auf den Stand zukommen, und bald vernehmen wir ein leises ununterbrochenes Knurren. Der Tiger kommt: er hält direkt unter uns an und schnauft geräuschvoll wie ein alter Eber oder

Büffel. Das Unisono-Knurren streicht mehrmals um unsern Stand herum, dann wieder dumpfe Schritte vom Hügel her, ein zweiter Tiger erreicht unsern Stand. Ich will sofort Licht machen und schießen, doch BÖHMER hält mich zurück, denn er möchte warten, bis die Tiere beim Aas sind, um gleichzeitig zum Schuß zu kommen. So halten wir uns weiter still und bleiben in großer Spannung; doch dieses Zuwarten wird uns zum Verhängnis. Die Tiger knurren noch unter uns, dann ein leises Knacken eines Ästchens, und wir hören keinen Laut mehr, außer der eintönigen Waldmusik. Die Tiger haben uns gewittert und sind geräuschlos verschwunden. Nach einer halben Stunde gehen wir zum Zelt zurück.

12. Juli. BÖHMER malt unser Lager. Ich selbst mache kostbare Insektenfänge am Waldrand und im Lalang. Am Abend sehen wir wieder eine große Hirschherde. Ich steige nochmals auf den Tigerstand und warte bis ein Uhr. Nur zwei Schweine werden angelockt, die Tiger erscheinen nicht mehr.

13. Juli. Am frühen Morgen brechen wir unser Zelt ab. Die Gajo sind traurig, die Tigerhütte, wie sie dieses Biwak nennen, schon verlassen zu müssen. Nach Überschreiten des Broesabaches beim Hauptkampong folgt ein steiler Anstieg auf eine bewaldete Hochfläche und dann ein langer Waldmarsch bis zum Blang Paja Karo, wo im Kampong Karang Ampar Reis und Zitronen gefaßt werden. Vor zwei Tagen sind hier Elefanten durchgezogen; die umliegenden Lalangfelder sind zertreten, und wir folgen den breiten Pfaden bis zum Waldrand. Um die Kolosse von Gärten und Häusern fernzuhalten, haben die Gajo längs der Waldgrenze den dürren Lalang angezündet; sie raten auch uns, sehr vorsichtig zu sein. Auf einem schmalen Pfad dringen wir etwa sieben Kilometer in den Wald ein, so daß wir noch genügend Zeit finden, bei Tageslicht unser Zelt aufzuschlagen und Feuerholz zu sammeln. Die umgebrochenen Stämmchen, die abgerissenen Äste und die noch frischen Elefantenäpfel deuten darauf hin, daß sich eine Herde in unmittelbarer Nähe aufhält, und ich finde es deshalb ratsam, bevor ich ins Zelt krieche, noch einige Kletterübungen zu machen und in Alarmbereitschaft einzuschlafen, vollständig angekleidet, den kostbaren Photoapparat umgeschnallt und Jagdlampe mit Karabiner in Handnähe.

14. Juli. Wir setzen unsere Wanderung fort durch prächtigen Urwald mit Schlingpflanzen und zahlreichen Orchideen. Bei einem Halt oberhalb des Peusanganflusses spielt BEDOEL auf seiner Gidjangflöte, und nach wenigen Minuten raschelt es in der Nähe, und ein Hirsch erscheint; wir wollen nicht schießen, und das Tier wird bald mißtrauisch und verschwindet. Dann marschieren wir auf einem dichtbewaldeten Kamm gegen den Fluß hinunter. Die beiden Träger BEDOEL und AMANSALE gehen etwa achtzehn Meter vor mir her, BÖHMER, JANSEN und AMANRIAM hinter mir. Plötzlich halten die zwei vor mir an, rufen irgend etwas Unverständliches, stürzen mit ausgestreckten Armen nach hinten, werfen die Lasten ab und laufen nach dicken Bäumen in der Nähe, die sie flink wie Affen erklettern. Ich vermute, ein Tiger oder Bär sei vorn und entsichere vorsichtshalber meinen Karabiner. Da taucht plötzlich eine breite graue Masse aus der Tiefe auf; ein ausgewachsener, männlicher Elefant mit etwa achtzig Zentimeter langen Stoßzähnen kommt direkt auf uns zu. Seine Bewegungen sind langsam, er nähert sich jedoch trotzdem mit bedenklicher Geschwindigkeit und zwingt uns, sofort auszuweichen. Der nächststehende dicke Baum ist mit starken Lianen umwunden und daher leicht zu erklettern; leider hält ihn JANSEN schon besetzt. Ich steige mit Karabiner und Photoapparat auf ein dünnes Bäumchen, das direkt daneben steht, mit der Absicht, mich oben in die Krone des größern Baumes zu schwingen; der Abstand erweist sich jedoch als zu weit, und ich muß vorläufig bleiben, wo ich bin, um nicht durch geräuschvolles Manövrieren die Aufmerksamkeit des Tieres auf uns zu lenken. In etwa vier Meter Höhe angelangt, beobachte ich gespannt, was drunten vorgeht. Der Elefant hat inzwischen die ersten Lasten erreicht und mit seinem Rüssel untersucht, die großen Blechbüchsen läßt er in Ruhe, während die Zeltlast mit den Vorderfüßen hin und her gerollt wird. Dann nähert er sich dem Rucksack unter meinem Baum. Die Schritte sind kaum hörbar, er geht wie auf Gummisohlen, die Ohren fächeln, der Rüssel pendelt suchend über dem Boden. Graue Riesenmasse — ich muß unwillkürlich an einen großen Möbelwagen denken. Der volle Rucksack scheint ihn zu reizen; er beschnuppert ihn, rollt ihn mit den Vorderbeinen, wie wenn er Fußball spielen wollte und wirft ihn schließlich in hohem Bogen über zwölf Meter weit ins Gebüsch hinein. Er geht weiter, direkt neben BÖHMERS Baum vorbei, der sehr dünn und unten angefault ist und zudem mitten im Pfad drin steht. BÖHMER ist wegen seines Unfalls noch schwach im Klettern und hat mit Mühe drei Meter Höhe erreicht. Er muß seine Beine dicht anziehen, um nicht den Kopf des Elefanten zu berühren. Die Aufmerksamkeit des Tieres ist glücklicherweise auf die Spuren am Boden konzentriert, sonst wäre es dem Koloß ein leichtes gewesen, den Baum umzustoßen, und ich hätte schießen müssen. Dann kommen ähnliche peinliche Sekunden für mich. Der Elefant scheint von einer unausgetobten Wut besessen zu sein, er schnauft vernehmbar und untersucht den Boden unter uns mit großer Gründlichkeit, zieht wieder hart an meinem Bäumchen vorüber, sucht weiter, scheint dann die Spur verloren zu haben und trabt plötzlich mit erhobenem Rüssel in ein Rotandickicht auf der Südseite des Grates. Er läuft durch das verfilzte Gewirr von Schlingpflanzen und Unterholz wie durch eine Wiese, einige Äste brechen, und die Rotanranken und Blättermassen schließen sich wieder hinter ihm. BEDOELS Hund ist spurlos verschwunden. AMANRIAM, der, kurz bevor der Elefant auftauchte, blindlings den steilen Hang hinuntergestürzt ist, läßt sich nach einer Weile wieder blicken und fragt, was überhaupt passiert sei. Er wundert sich sehr, daß die Herren nicht geschossen haben; wenn er ein Gewehr gehabt hätte, würde er den Elefanten ohne weiteres zusammengeknallt haben. BEDOEL versichert uns, was BÖHMER und ich schon vermutet haben, daß der Elefant ein Einzelgänger, d. h. ein aus der Herde verstoßenes Männchen gewesen sei. Diese wilden Gesellen seien viel unternehmungslustiger als die eher harmlosen und scheuen Herdentiere, und es sei schon vorgekommen, daß sie Fruchtgärten der Gajo wütend in den Boden gestampft und ihre Hütten wie Kartenhäuser umgedrückt hätten.

Über den reißenden Peusangan führen zwei locker übereinandergespannte Rotanseile, und die Träger haben Mühe, ihre Lasten auf das andere Ufer zu balancieren. Am Nachmittag

erreichen wir das Blang Timbang Gadja und die Straße Bireun — Takengon. Nun müssen wir auf eine geeignete Transportgelegenheit warten, um nach dem Blang Rakal zurückkehren zu können; sie erscheint leider erst nachts um zehn Uhr in Form eines Chinesenlastwagens. In der Zwischenzeit setzen wir uns auf die Weide, kaufen von einer Marktfrau für zwanzig Cent ein großes Bündel Bananen und verzehren diese gemeinsten aller Früchte Indiens mit großem Appetit. Wir lassen das Erlebte nochmals an uns vorbeiziehen und bedauern, dieses romantisch wilde Gajoland bald mit der betriebsamen und brütendheißen Tiefebene vertauschen zu müssen. Spät am Abend lädt uns ein Gajo ein, in seinem nahen Kaufladen und Kaffeehaus Platz zu nehmen. Die Wände des luftigen Palmblattbaues sind mit Zeitungspapier austapezeirt, und das gleiche Material breitet der freundliche Wirt auf Bänken und Tischen aus.

15. Juli. BÖHMER und ich haben eine Metamorphose durchgemacht und erscheinen, statt im zerknitterten Khakihemd, wieder im blendend weißen steifen Anzug, der Uniform der Herrenrasse, die Distanz schafft und ihren Träger mit Vorrechten ausstattet. Wir haben jedoch die Gajo als zuverlässige und liebenswürdige Kerle kennengelernt und spielen unsere würdevolle Rolle schlecht; wie wir auf einem Abstecher nach Takengon bei Timbang Gadja vorbeifahren, kommt es zwischen unsern Bekannten des Kaffeehauses und uns zu einer herzlichen Begrüßung.

# RUMPHIUS, THE BLIND SEER OF AMBOINA

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Like many others who have achieved eminence in the study of nature in the Netherlands East Indies, the "blind seer of Amboina" was of German birth, but "at heart and in speech Dutch." Bound by affection to the island where destiny had placed him, for almost fifty years he endured great trouble and found great happiness in his work.

For a long time it was uncertain in what city and on what day he was born. Without doubt these data will always remain vague, although they have become much clearer than they were twenty years ago. Most arguments favor the little city of Hanau on the Main as his birthplace; in any case he lived there in his early youth and attended the gymnasium. Or was it perhaps Münzenberg in the Wetterau? And when was his birthday? In a letter to the Councillor-Ordinary, ISAAC DE ST. MARTIN — an important record — he himself all but gives the date of his birth: "Amboina, Castle Victoria, May 15th, 1691, being the close of my 63rd year." Thus RUMPHIUS must have been born shortly after May 15th, 1628. And from the poem composed on July 7th, 1696, by the late governor of Amboina, NICOLAAS SCHLAGEN, for RUMPHIUS at the age of 68, it appears that he must have been born before the 7th of July, 1628. Therefore, in all probability, the great naturalist began [1] his life in the latter part of May or in the month of June.

There are many biographies of RUMPHIUS; there are almost as many opinions about the year of his birth as there are stories of his life. The dates commonly given are 1626 and 1627, in occasional works it is even 1637 or 1676.

In a nicely written biography of the "Indian Plinius" in the *Java-Bode* by PAPAGENO,[2] we find the following lament: "Golden cups were poured for admirals, with golden chains were the returning governors bound, but for someone who had written a standard work and thereupon had labored for more than the half his life, it was sufficient to explain cleverly one of his creations to the dealer."

And what is the present attitude in this respect? How many are there in our land who can name the naval battles of Vlissinger MICHIEL from memory and relate precisely when the different English wars took place, yet who have never heard of such a man as RUMPHIUS, or at most know only his name, since one of the ships of the "Koninklijke Paketvaart-Maatschappij" is named after him? And this, notwithstanding the existence of a splendid work, published in 1902 by the Colonial Museum at Haarlem on the occasion of the 200th anniversary of his death, which surely is to be found in all the great libraries of our country!

All over the world this monumental volume offers opportunity to anyone desirous of learning something more about this greatest of our seventeenth-century oriental naturalists. One of the reviewers of the book states, "more effectively than any statue ever cast in bronze, this memorial is dedicated to the task of pointing out the great significance of RUMPHIUS' little-praised work both for the present generation and for posterity." Moreover, in 1871, LEUPE gave us a beautifully documented biography in which he brought together everything which was found about RUM-

* Based on Chapter II (G. E. RUMPHIUS) from the author's "Indisch Natuuronderzoek" (Diss. Amsterdam, 1915). Grateful acknowledgment is made of the help rendered by Dr. E. D. MERRILL, of Harvard University, in making the above account ready for publication.

[1] *Cf.* G. P. ROUFFAER & W. C. MULLER, 1902: Eerste proeve van een RUMPHIUS-Bibliographie. (RUMPHIUS-Gedenkboek, published by the Colonial Museum, Haarlem, 15 June 1902, p. 165–220). p. 206, note 2.

[2] ("PAPAGENO") 1896: De Indische Plinius, I–VI. (Java-Bode, February 1896, Nos. 30, 33, 36, 38, 41, and 44).

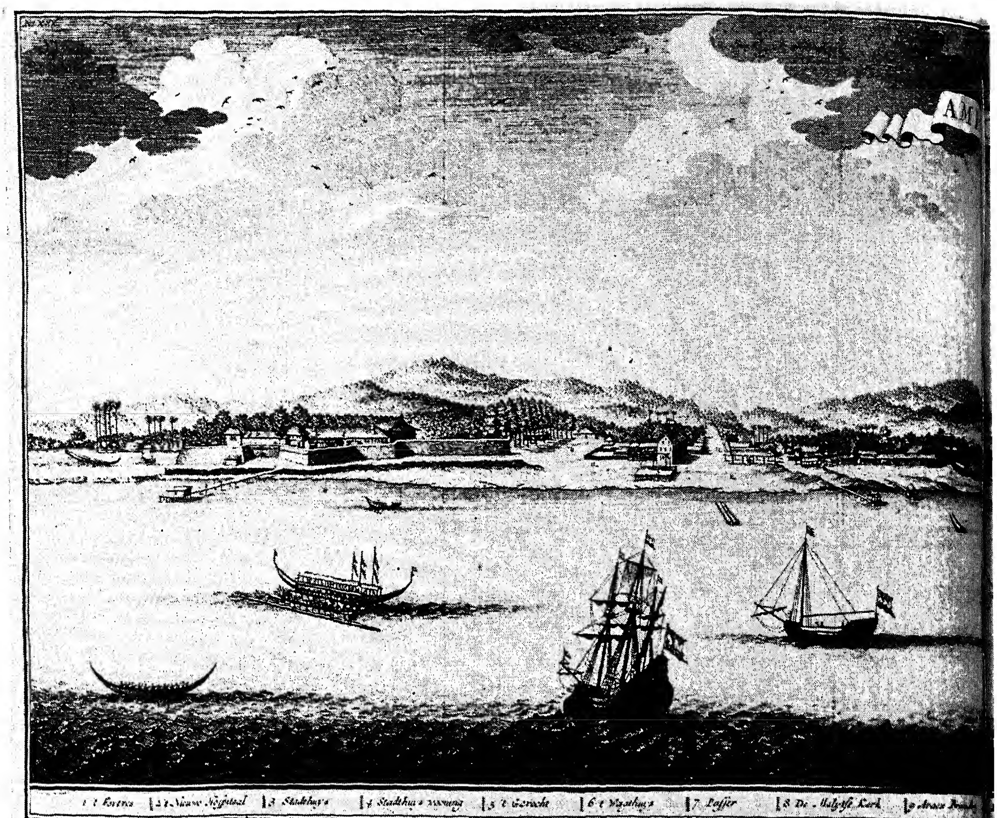

FIGURE 76. — VIEW OF AMBOINA (Plate 30 of VALENTIJN'S

PHIUS in the archives of the former East Indies Company.

GEORGE EVERHARD RUMPF spent his youth in Hanau, where his father, AUGUST RUMPF, held the important position of architect. But that life did not appeal to the restless young JEURIAEN. Being adventurous, he wished to see more of the world than little Hanau. With that aim and at the request of his prince and master, Count LUDWIG VON SOLMS-GREIFENSTEIN-BRAUNFELS, he enlisted in the Venetian army.

It appeared very quickly, however, that the representations of the Count were not fully trustworthy, and that he had been brought into service with the Netherlands West Indies Company. The plan was that the soldiers, recruited in the Netherlands by Count SOLMS, should be conveyed by ship (as opportunity arose) to Venice, after which the ship would change its course and take them to Brazil. But thanks to an attack by the Portuguese, the "Swarte Raef," the ship on which RUMPHIUS and his companions in misfortune had embarked at Texel, was brought to Portugal. There the men were retained for Portuguese military service.

This period marked the turning point in RUMPHIUS' life. In Portugal his urge to adventure was unexpectedly diverted into another channel. Here he heard so many tales of all the remarkable things which the East produced, of the wonderfully luxuriant plant growth, of a strange fantastic animal world, that his desire to travel was strongly increased, but at the same time ennobled. At this time he appears to have taken up a plan to improve his studies. Years later in one of his letters to the governor of Amboina, July 18th, 1669, he wrote, "This being the chief aim, because I have given myself to the Indies."

About 1648 or 1649, after leaving Portugal, he returned to Hanau for a short time. At the end of 1652 he enlisted as midshipman in the East Indies Company; from that time on, he was among its most loyal and conscientious servants.

The day after Christmas, 1652, he departed with the yacht "Muyden" from Texel and arrived safely at Batavia, Java's chief city, in June 1653. Still in the same year, apparently November 8th, he went from there to the place of his future residence, the island of Amboina. Military service did not satisfy him. He was "a master of many sciences," and very soon he was promoted to ensign; nevertheless, at the same time inquiries were made concerning his capabilities for construction work. The result was that JACOB HUSTAERDT, governor of Amboina at that time, transferred him to civilian service, and in 1657 named him as undermerchant (ranks in the East Indies Company were assistant, undermerchant, merchant, and chief merchant). In 1660 HUSTAERDT asked that RUMPHIUS be appointed merchant. This request was granted in an official letter, February 17th, 1662, by the governor-general, and RUMPHIUS was assigned a salary of 60 guilders a month.

About this time RUMPHIUS began to make a systematic study of the flora and fauna of Am-

"Beschrijving van Amboina," Vol. 2, 1724).

boina. On the 20th of August 1662, he sent "to The Noble, Honored, Venerable, Wise, Provident, Highly Informed Masters, the Noble Chief Directors of the East Indies Company residing at Amsterdam," "a small request," "a polite request," "as, Your Excellencies, [he] is in great need of help."

The importance of this letter is certainly sufficient justification for quoting some parts of it here. It presents a kind of program of work that RUMPHIUS had planned for himself and that he now communicated to the Directors. Characteristic of his modesty are some excerpts from this remarkable letter: "It is thus, then, that I have begun a work which anticipates as its goal descriptions of such plants, vegetation, animals, etc. as I have seen, and may yet see, during my residence in the Indies. These descriptions are to be written in Latin. In this work will be treated entities which I have selected, correctly named from the old Greek, Arabic, and Latin authors, as well as from more recent ones, with their similarities and differences, and figures suitably drawn according to life (in as far as I am able); everywhere is to be included the characters and strength, not only those culled from former descriptions, but especially those worked out most diligently through my own experience. In fact, part of these have been examined and brought together, with various other researches concerning the physical and mathematical sciences. Everything is directed to this single purpose, then, that it may be accomplished with greater care than has been done previously." In addition, he had "need for all sorts of standard books to serve as a compass and a support of memory in this Indies' wilderness."

And he continued, "Let it be considered then, Venerable Masters, that my undertaking is a work which at this time appears trifling and concerns my personal interest most of all; nevertheless, remember the old saying that mighty things from small beginnings grow; also these, my lucubrations, should be able to bring service and pleasure to some generous spirit or other, yes, even to many Europeans, particularly to those living in these eastern lands under the illustrious government of Your Excellencies. These may now or later derive some profit and service from my writings, especially in the matter of preserving their health. The latter asset, we in the Indies, up to the present time, have relinquished in large measure owing to our ignorance of the remedy which frequently lies at our feet."

Then RUMPHIUS "very earnestly and respectfully" requested the Directors that the books and instruments purchased through his friends, among whom was Ds. RULICIUS in Amsterdam, be sent out to him in good condition and not "similar to those which [he] had already found damaged," "out of suspicion, as often mercantile articles, particularly, were brought over spoiled and wrongly delivered (with such trifling I have never wished to belittle myself)." The Honorable Directors listened to RUMPHIUS' "small request" and to the recommendation which JOAN MAETSUYKER, governor-general, gave to RUMPHIUS' writings. They took the books under their

protection, with the provision that, beforehand, the packages should be examined in the storehouse. Nevertheless, one can never be sure that there was no contraband in the packages for RUMPHIUS!

Thus several years passed, spent by RUMPHIUS in the service of the Company, devoting his free time to studying and writing about the Amboina flora and fauna, its products and its history. At first the Company was blind to this work, but later, principally on account of the influence of MAETSUYKER, lent it the patronage of its authority. To RUMPHIUS was given the promise that he should never be displaced, and that he should have "as much leisure as desired whenever possible without neglecting his service for the Company," for before everything else RUMPHIUS was the servant of the Company.

Nevertheless, RUMPHIUS no longer belonged whole-heartedly to Amboina. He wished eagerly to be free, to give himself entirely to "his curious studies." Always the position of merchant and chief of Hitoe was a mask, a necessary evil — necessary since he now must gain a livelihood for himself and family. It was his wish that soon he might be freed from all administrative and official perplexities in order that he might complete his writings and, for future maintenance, be able to move to Batavia. Actually it seemed that he might reach his goal. In the beginning of 1669 formal consent came from Batavia. He obtained leave of absence, with permission to lay aside his present duties and to proceed there. Because of various circumstances — among others, the lack of a reliable ship to transport himself and his family, and the correspondence which took place between him and the governor of Amboina with regard to this — he delayed his departure again and again. Finally, fate intervening, the repeated deferment of his plans resulted in his renouncing them entirely.

It now appeared as though the happiness and prosperity which had attended RUMPHIUS up to the present time as true comrades, deserted him and left him to the caprice of destiny. Early in 1670 the naturalist, who achieved his life's happiness from the observation of nature, was stricken by a calamity greater and more deeply tragic for him than for any other person. Through too long exertion in the tropical climate RUMPHIUS had demanded too much of his eyes. He became blind. Quite terse indeed, as LEUPE observes [3] in his biography of our scholar, was the message in which the governor of Amboina, JACOB COPS, communicated this very sad event to the High Government at Batavia: "The merchant RUMPHIUS has now been blind some weeks."

Could there be for so eager and vigorous a man as RUPMHIUS a more serious disappointment or a more conceivable misfortune than the loss of his eyesight, a loss compelling him, desirous of seeing everything himself and not wishing to trust to the sight of others, to do his work in the future "with borrowed eyes and hands?" And does not this man merit our full sympathy and regard, who, notwithstanding the very tragic lot that had become his part, continued with iron will the work to which he had pledged his life?

Governor COPS, however, considered our scholar no longer the man to hold so important a post as "Chief of Hitoe." On the 20th of May, 1670, he informed RUMPHIUS that he would be relieved of his duties, and invited him with his family to go to Castle Victoria to await there the further decision of Governor-General MAETSUYKER concerning his future. The outcome for RUMPHIUS was much more favorable than he apparently had hoped after his somewhat rude reception by COPS. MAETSUYKER believed that Governor COPS had been a little hard on the unfortunate man, and that the interests of the Company were compatible with other measures.

The arrangements made by MAETSUYKER are indicative of his sympathy for the fate of RUMPHIUS. "At the request of the merchant RUMPHIUS . . . it is resolved and decided in the first place that his wages shall continue until further order, since it still appears that he is not without hope of recovery. Perhaps also his return in person to Hitoe still may possibly be considered, all the more because of his long tenure, able and irreproachable service. However, except for the wages, everything else must be for the benefit of the Company, as is the custom here with people who are not in the service. But, nevertheless, it is understood, as far as he personally is concerned, that he is to appear in the councils of the governors and justices as in other meetings of the Company. Furthermore, he shall now have the facilities for appearing everywhere in his old seat and rank, without suffering any loss in this respect." Does not this reveal MAETSUYKER's effort to prevent the blind man from feeling his loss? And does not this show his firm belief that RUMPHIUS' keen understanding and clear insight in important matters had suffered no damage through the loss of his eyesight? And the Company could well use similar "long, able and irreproachable services" from her employees.

RUMPHIUS therefore remained in Amboina, heartened by the interest of the Company and applying himself at once to his beloved studies. He gave the government able advice, both written and verbal, on fortification works, agricultural grants, etc. Meanwhile the activities required of him were not too pressing, and allowed him sufficient time to accomplish his work.

But even after his becoming blind, fate did not cease torturing him. Four years later, February 17th, 1674, RUMPHIUS' wife and youngest daughter were victims of a violent earthquake which devastated Amboina. "Pitiful it was indeed to see this man sitting by his dead, and to hear his repeated lamentations encompassing both this new casualty and his own blindness."

Yet the weight of such a serious disaster was not sufficient to break so zealous a spirit as RUMPHIUS. He found consolation in his work. True, his melancholy dejection persisted several years, and at times it seemed as though he had lost all desire for work. Gradually, however, he recovered from this blow with a resilience compelling admiration.

It was as if fate now was satisfied with the sacrifices demanded of RUMPHIUS. Further trials were before him, although as far as his personal life was concerned, he was spared. His scientific work, more than once, laid burdens on his shoulders which for another would have seemed too

[3] P. A. LEUPE, 1871: GEORGIUS EVERARDUS RUMPHIUS, Ambonsch natuurkundige der zeventiende eeuw. (Verhandelingen Kon. Akad. v. Wetensch. Amsterdam, XII, Chapter 3, 1871, p. 1–63). p.14.

*Cf.* also J. E. HEERES, 1902: RUMPHIUS' levensloop naar de mededeelingen van P. A. LEUPE. (RUMPHIUS-Gedenkboek, 1902, p. 1–16).

heavy. For thirty years RUMPHIUS assisted the Company in all possible ways. For example, up to June 8th, 1700, he remained chairman of the "Collegie des kleynen Gerigts- en Huwelyckszaecken," on which day, after repeated entreaties, he was relieved of this duty, as he "was indisposed on account of his increasing age and could not attend this assembly regularly." The Company did not willingly release so faithful a servant. The fact that RUMPHIUS himself insisted on a decrease in his activities indicates how much his strength had failed at that time. He for whom no task was too difficult, felt he could no longer render what his position in the Company required. It was his wish to try to finish his scientific work before the end came, and this privilege was granted him.

He died the 15th of June, 1702.

Such was the life of the Company-employee, G. E. RUMPHIUS.

For him, his official position was a pretext; at heart he was a servant of science. Although he was one of the most conscientious and deserving among the employees, and always performed the tasks assigned to him with the greatest care, his office was not the place where he could use his talents most fruitfully. He felt at home only with nature and in its study. His approach to science was extraordinarily versatile. Everything which nature offered held an attraction for him. The history of the land whither destiny had borne him and its geographic conditions interested him. His beautiful *Amboinsche Land-Beschrijving* and *Amboinsche Historie* are eloquent witnesses of this.

In the world of natural science RUMPHIUS has written three great works: an *Amboinsch Kruidboek*, an *Amboinsche Rariteitkamer* and an *Amboinsch Dierboek*. He looked upon the *Kruidboek*, the "Herbarium Amboinense," as his chief work. Evidence for this is found in the following quotation: "Among the writings of the aforementioned merchant RUMPHIUS are still some others of lesser importance; consequently, Right Honorable Gentlemen, he dares not recommend them very much. There are the *Amboinsche Rariteitkamer* consisting of three books, and still three other books of Land-, Lugt- en Zeegedierten of these islands . . ." (from a letter of the Governor of Amboina to the High Government dated May 20th, 1697).

The *Kruidboek* was the first work which he undertook after his arrival in Amboina. Precisely at what time he began this work is not known; at any rate, in 1663, he had already been occupied with it for some time. He himself collected the data, wrote the Latin descriptions of the plants with the brilliant accuracy of an ingenious amateur, and drew as many plates as possible, modestly including them. Alas, these original drawings were all destroyed; not a single one has been preserved to this day.

After becoming blind in the spring of 1670, he was constrained to give up this particular part of the work. Now, he was obliged to trust the proficiency of others in drawing. Other hands must put into writing what RUMPHIUS knew about the plants illustrated and what he still learned from them; but his spirit continued to animate the work. He investigated the importance of insignificant facts, truths, and folklore.

Soon after his blindness there followed, in 1674, the dire misfortune that befell his wife and youngest daughter. They were among the numerous victims claimed by the great earthquake of February 17th. Great was the depressing effect of this mournful disaster upon our scholar. The man who had adapted himself with admirable cheerfulness to the loss of his eyesight was by this trial for the time being intellectually stunned. His official work was performed faithfully, but he lacked desire for his beloved studies. Presently we see the working power of the spirit slowly conquering in the struggle for immediate existence, and eventually, the man of science perpetually longing and yearning for the utmost mental achievement awoke out of a stupefying sleep.

In 1679 and 1680 respectively, the High Government granted RUMPHIUS a "clerk" and a "provisional assistant," DANIEL CRUL, to help him, with his work. Meanwhile in 1685, a certain JB. HOGEBOOM drew plates for him. RUMPHIUS' son, PAULUS AUGUSTUS, also assisted his father, at least from 1686 when he, likewise an employee of the Company, was transferred as assistant from Batavia to Amboina.

Thus was brought together by RUMPHIUS, with the help of others, a wealth of observations concerning the wonders of the Amboina flora and some individual species from other parts of our Indies so rich in luxuriant vegetation. The governor, DIRCK DE HAES, was able to write thus of it, "Now the same was as good as finished, and in it were 1720 chapters included in twelve books, of which entire work the half of the necessary figures were drawn by himself and others."

Then the man already so tried in his personal life met with still more affliction, this time in his scientific work. In a disastrous fire, which on the 11th of January destroyed the entire Netherlands section of the town of Amboina, RUMPHIUS' books, collections, and manuscripts as well were in a large measure destroyed. "The principal work was barely saved," but all illustrations and hence all drawings made by RUMPHIUS himself before 1670 were the prey of this thoroughly destructive fire.

Again the powerful personality of RUMPHIUS rose above this misfortune. At his request the governor informed the officials of the High Government that "since Your Excellencies are of the opinion that this work should be brought to completion, there will be sent to serve next year a draughtsman, who, with RUMPHIUS' son AUGUSTUS, should be able to repair the damage in about another year and a half or two years. Also, it was decided that the aforementioned work without illustrations would be of little value and receive scant consideration. Meanwhile, only the principal losses should be made up." When the government officials answered this — the liberal thinking CAMPHUYS was then governor-general — they showed again their warm interest in RUMPHIUS' scientific work by sending him a draughtsman, a cabin boy, PHILIPS VAN EYCK, who might qualify[4] himself in drawing under the guidance of PAULUS AUGUSTUS RUMPHIUS.

Because they all worked together, the damage was quickly repaired. In the latter part of 1690 the first six books were ready to be sent to Batavia, where they were to be re-directed to the homeland. Thus in the middle of 1692 we find

[4] *Cf.* concerning the manuscripts of the Kruidboek and what happened to them: J. P. LOTSY 1902 Over de in Nederland aanwezige botanische handschriften van RUMPHIUS. (RUMPHIUS-Gedenkboek, 1902, p. 46–58).

this manuscript on board the ship "Waterland" bound for the Netherlands; yet it was destined never to reach there. On the 12th of September, the "Waterland," the admiral's ship of the homebound fleet commanded by WILLEM KEMP "with crew and all very lamentably was sunk" by the French and "not more than a dozen men were saved."

HENSCHEL in his beautifully elaborated study, *Vita G. E. Rumphii* [5] writes, "But neither the sun which blinded the writer with its rays, nor the fire that consumed his writings, nor the water that buried the manuscript beneath its waves, could deprive the world of this precious piece of work." And indeed it was as if the careful patron of our scholar, the old Governor-General CAMPHUYS, had foreseen the possibility of such a fate. We are indebted to him for his precaution in copying these books before entrusting them to the hazards of a distant journey. Whatever motives may have prompted CAMPHUYS to make this transcription — even if we take into account that his "predilection for copying the writings of others was somewhat suspicious" [6] — we must not forget that, through his action, an irretrievable loss was prevented. Now, with CAMPHUYS' permission, it was possible to have the copy transcribed again and to send the first one to Europe.

Thus it came to pass that on the 8th of February, 1696, the manuscript-copy was sent with the ship "Sir Janslandt." It also carried books seven, eight, and nine which, meanwhile, had been sent by RUMPHIUS from Amboina to Batavia, and in turn transcribed. These were followed promptly by the last three books which also were first painstakingly copied at Batavia. The custody of these duplicate copies at Batavia was assumed by CAMPHUYS until his death, July 18, 1695, when the responsibility was taken over by ISAAC DE ST. MARTIN, and after his death on April 14, 1696, by CORNELIS CHASTELYN. Finally, September 24, 1701, an "Auctuarium" was sent to Batavia with the request to have it copied in every particular, since "of all figures placed therein, very few or no originals or sketches of them were left here (in Amboina)."

With the despatch of the last three parts, the two helpers of RUMPHIUS, the provisional assistant, JOHAN PHILIP SIPMAN, and the draughtsman, PHILIP VAN EYCK, departed for Europe. Before leaving, VAN EYCK had taught a soldier, PIETER DE RUYTER, to draw, so that this man could substitute for him after his departure in September 1696.

The Directors in Amsterdam admired the work of RUMPHIUS greatly. They found it of "particular interest and it surely contained therein various useful and noteworthy matters" According to the opinion of the Noble Seventeen it is "truly a work that we find to have been brought together and arranged with much skill, study, and application; it has, among other important things, several items which are not only matters of speculation and curiosity, but which also have a specific utility and cast light on diverse subjects, particularly in regard to the spices of the Moluccas, the culture and shipping of these, etc. . . ." The Directors did not wish such a "praiseworthy work" "to be unrewarded." Therefore they "thought it fitting to remunerate the aforementioned RUMPHIUS by promoting his son, P. A. RUMPHIUS, undermerchant and chief of Larique, to the position of merchant with a salary of fl.60 per month."

However beautiful the Noble Seventeen found this work, they still did not think it exactly suitable for publication. A request from some admirers and printers was declined on February 19th, 1700, with these words, "After deliberation it is understood that the publication of the aforesaid books is not desirable." Two years later, September 15, 1702, the Nobles changed their minds and "approved the *Kruidboek* of the elder merchant G. E. RUMPHIUS, in the years . . . sent hither, and they tried to influence some friends to arrange for the publication of this either as a whole or in part, nevertheless everything was to be without expense to the Company." At that time no friend offered this assistance.

Years passed before the "Herbarium Amboinense" was mentioned again in the resolutions of the Noble Seventeen. About 1736 the Amsterdam Professor JOHANNES BURMANNUS resolved to have the *Kruidboek* published. He received permission "for these same books to be published then without expense to the Company, and further, without bringing in any passages which might be damaging to the Company." Likewise, in his biography of RUMPHIUS, Professor HARTING had written,[7] "Everything which concerned the political and commercial importance of the Colonies and the advantages therefrom were impounded for the motherland, and the employees of the Company would be charged with treason if they should make anything known to the world without its express permission."

Originally RUMPHIUS had written his work in Latin (*cf.* his letter to the Honorable Directors dated August 20, 1663, a work . . . written in Latin) but later translated it into the Netherlands language. BURMAN thought it useful to translate it again into Latin and to publish both texts together. Thus appeared *Het Amboinsche Kruidboek*. It contains descriptions of the best known trees, shrubs, herbs, land and water plants which are found in Amboina and the surrounding islands. It tells something of their habit, their names in various languages, their cultivation and use; likewise it includes some insects and animals, mostly accompanied by their appertaining figures, all gathered together with great pains and diligence over a period of years and described in twelve books by GEORGIUS EVERHARDUS RUMPHIUS . . ."

It was published in six folio parts between 1741 and 1750.[8] The "Auctuarium" appeared as the seventh part in 1755, likewise through BURMAN's care.[9]

[5] A. G. E. TH, HENSCHEL, 1833: Vita G. E. Rumphii, Plinii Indici . . . Vratislaviae (Breslau) 1833, p. 42.

[6] ROUFFAER and MULLER, 1902, p. 185, note 6.

[7] P. HARTING, 1885: GEORGE EVERHARD RUMPHIUS geschetst door. . . . (Album der Natuur, 1885, p. 1–15). p. 11.

[8] Publishers of this work: at Amsterdam, FRANÇOIS CHANGUION en HERMANUS UYTWERF; in The Hague, PIETER GOSSE, JAN NEAULME, ADRIAAN MOETJENS en ANTONY VAN DOLE; for parts I–IV besides in Amsterdam, JAN CATUFFE and in Utrecht, STEVEN NEAULME. In 1750 the name of MEINARD UYTWERF of Amsterdam appeared on the title page. He had purchased the rights of publication.

[9] The Auctuarium was published by MEINARD UYTWERF and the "Wed. S. SCHOUTEN EN ZOON." Further bibliographic particulars about this publication are to be found in the previously mentioned "Eerste proeve van een RUMPHIUS-Bibliographie" by G. P. ROUFFAER and W. C. MULLER (RUMPHIUS-Gedenkboek, 1902, p. 165–220), a work so beautiful in design and effect and so full of interesting information that the title "Eerste proeve" is most modest .

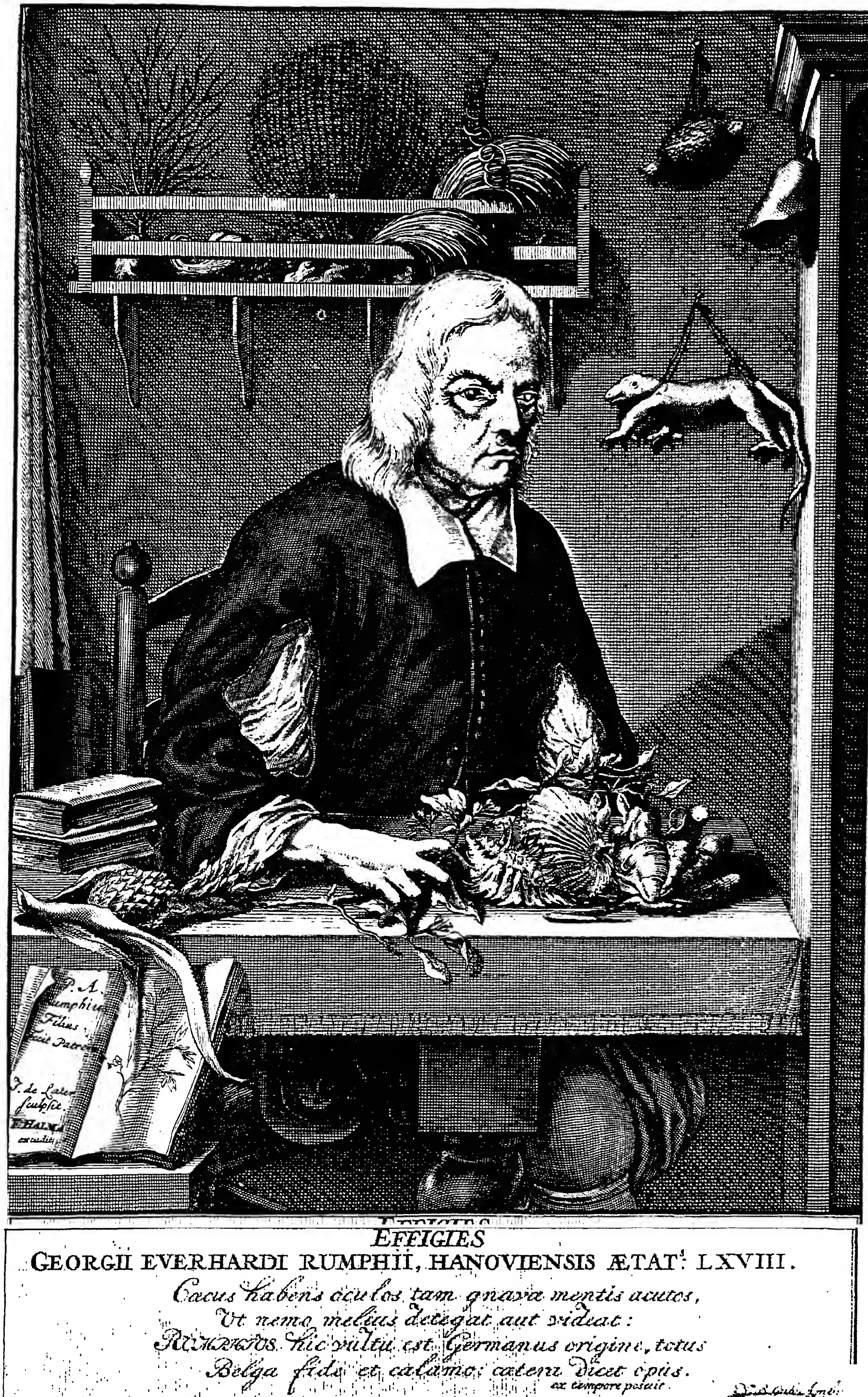


FIGURE 77. — GEORG E. RUMPH, *from his* "D'Amboinsche Rariteitkamer."

At the time when RUMPHIUS elaborated his "Herbarium Amboinense," the systematic arrangement of plants was still in its infancy. The categories outlined by VAN REEDE were followed by RUMPHIUS. A short statement of the titles of the twelve books will be sufficient to indicate this method of arrangement, drawn up in a lavish variety of forms.

Book I. Trees cultivated for their edible fruits.
Book II. Aromatic trees with either spicy fruits, or barks, or richly fragrant wood.
Book III. Trees producing resin, showy flowers, or injurious latex.
Book IV. Timber trees.
Book V. Other common trees.
Book VI. Shrubs both cultivated and wild.
Book VII. Forest lianas and creeping shrubs.
Book VIII. Herbs used chiefly for food, medicine, and adornment.
Book IX. Vines and creeping herbs.
Book X. Common wild herbs.
Book XI. Other native herbs.
Book XII. Small seatrees [alcyonarians] and stony seaweeds [corals], similar to plants.

Although such categories lack all scientific principle, they have a natural charm. "The trees which yield resin, have ornamental flowers, or give off injurious latex," "bosch-touwen" for lianas. Are these not proofs of the unprejudiced view with which RUMPHIUS observed nature in Amboina?

In all the chapters RUMPHIUS gives not only descriptions of the external features of the plants discussed (descriptions for the most part accurate in small details except where minute flowers were concerned), but also a number of excellent drawings perfectly true to life. Furthermore, he tells about the products furnished by the plants, the places where they may be found or cultivated, the time of flowering, the mode of cultivation, their uses both medical and technical, and other particulars. In addition to the Dutch, Malayan, and Latin names, wherever possible, he gives native names used in Amboina, Ternate, Banda, Makassar, Java, sometimes those of Arabia, China, Portugal, and Hindustan. "And he did not have available," says HENSCHEL in his biography,[10] "as did VAN REEDE, the advice and knowledge of scholarly Europeans and Brahmans, but had to exhaust life itself and through his own experience in this Indies' wilderness obtain his knowledge with great diligence." He also communicated everything relating to the manners and customs of the people; for example, what superstition prevailed there about a definite plant, constantly separating legend from truth. Then he compared his results with information from PLINIUS, ARISTOTELES, his immediate predecessors, BONTIUS, GARCIA AB ORTA, and others, thereby continually giving proof of being highly discerning and brilliantly erudite.

His observations were clear. If he were not quite sure of the accuracy of his information, he mentioned this explicitly. For example, he sought a solution for the then problematical occurrence of the "coco de mer" fruit of the Seychelles palm which is sometimes washed ashore in the Indies. Hesitantly he explained it. He was fully aware of the lack of facts and attached little value to his supposition that the fruits mentioned might belong to a plant growing under the sea. On the other hand, in a number of instances, he had the opportunity of pointing out the singular character of the tropical flora, the existence of biological peculiarities in plant life of which people in northern regions had never dreamed. His "bosch-touwen," the well-known pitcher plants whose cups must not be considered as fruits of the plant but "only as an excrescence of the leaf"; the interesting phenomenon of cauliflory still difficult to explain in our time; that is, the actual development of the fruit on the trunk, as in Cacao, and a number of other important biological observations are his. This is his description of the remarkable parasitic plant *Cassytha*: "Resembling the feet of the fish 'Polypus'; that is to say, it has short fingers simulating whitish warts with which it sticks fast to the aforementioned branches and draws its living from various hosts, in the same manner as *Viscum*, our mistletoe; consequently, one must consider these little feet as roots, which are so spread over the entire shrub that one cannot even conjecture where the primary root developed."

RUMPHIUS also reached important conclusions regarding the distribution of plants. He mentioned the probable origin of a number of American plants which came to the Netherlands colonies principally through trade with the Spaniards and Portuguese. In connection with the dispersal of *Carica Papaya*, for instance, RUMPHIUS thought of the possible co-operation of birds. In truth, much has already been said about the matter by JAN HUYGEN VAN LINSCHOTEN.

Thus, in its own right, the *Amboinsch Kruidboek* is a standard work of lasting value, a permanent source of information, even for botanists of the twentieth century. OTTO KUNTZE made an effort to have the year 1737 considered as the beginning of priority in nomenclature, so that RUMPHIUS' names would also be included, but he was unsuccessful. The officially accepted date is that of LINNAEUS' *Species Plantarum*, 1753. Consequently the designations in the "Herbarium Amboinense" will always be excluded from consideration in questions of nomenclature. Since the manner of naming plants at the present time is quite different from that of RUMPHIUS, it is not always easy to find a definite plant in the "Herbarium Amboinense." Important and helpful expedients are the "Clavis Herbarii Amboinensis" of HENSCHEL [11] and the "Neuer Schlüssel" of HASSKARL.[12] For studying RUMPHIUS' *Kruidboek* the latter is more valuable, since it contains the results of a botanical trip through the Moluccas, carried out (1853–1860) by TEYSMANN, director of the Buitenzorg Garden. On this expedition a number of plants still unknown at the time of HENSCHEL were re-discovered. In addition to an ample discussion of all twelve books of the *Kruidboek*, HASSKARL gives a threefold alphabetical index: one for the Latin names of RUMPHIUS; one for native names; and one for the scientific systematic names which were valid in 1866.*

[10] A. G. E. TH. HENSCHEL, 1833, p. 50.

[11] A. G. E. TH. HENSCHEL, 1833, p. 139–202.

[12] J. K. HASSKARL, 1866, Neuer Schlüssel zu RUMPH'S. Herbarium Amboinense. (Abhandl. Naturf. Ges. Halle, IV, 1866, p. 143–389.

* The latest comprehensive work on RUMPHIUS' "Herbarium Amboinense" is "An Interpretation of RUMPHIUS's Herbarium Amboinense" (Bureau of Science Publication no. 9, p. 1–505, 2 maps, 1917, Manila), by E. D. MERRILL. This was in part based on extensive botanical collections made by C. B. ROBINSON in Amboina, July 15, 1913 to December 5, 1913, the date of his untimely death in Amboina by the hands of natives. Dr. ROBINSON was sent to Amboina from Manila primarily to collect in that classical locality material that could be used to interpret the plant forms described and illustrated by RUMPHIUS, giving special

FIGURE 78. — RUMPHIUS' TOMB IN AMBOINA: "G. E. Rumphii sepulcrum in ipsius Horto Amboinae instauratum."
*(From* BLUME's Rumphia, 1835 *seq.*

RUMPHIUS' significance as a botanist is distinctly manifest. With his floristic descriptions he not only laid the foundation for a knowledge of the vegetation of Amboina and other islands of the Indian archipelago, but also brought together a great number of significant facts which he had observed about the life of plants. In so doing he initiated the biological study of tropical floras.

It is much more difficult to estimate the value of RUMPHIUS' zoological work to its full extent. The *Amboinsche Rariteitkamer* gives us an insight into his methods of work and a brief summary of his many interesting discoveries. Still it must be admitted that the *Rariteitkamer* was written more particularly for nature lovers, who in his time were very numerous.

This is, in no sense, a fair criticism of RUMPHIUS as a zoologist. In addition to the *Rariteitkamer*, he elaborated another manuscript entitled "Van Land-, Lugt-, ende Zeegedierten deser eylanden." It is still not known whether he finished this study. In 1697 the governor of Amboina wrote to the High Government regarding both these works, "He himself has little courage for perfecting these owing to the infirmities of old age." But he willingly labored on "for the zest which work gives, otherwise he must end his days in melancholy."

Nothing is known of the *Amboinsch Dierboek*; the manuscript seems to have vanished. As it never appeared in print, we are not in any position to evaluate it. Whatever part of it has been published, and perhaps this is more than one might surmise, was not under RUMPHIUS' name, but was adapted in the "Verhandelingen der dieren van Amboina" by Ds. VALENTYN. It has now become certain what LEUPE [13] and a number of others including WARBURG,[14] suspected that VALENTYN used RUMPHIUS' plates and manuscript freely in his "Oud en Nieuw-Oost-Indiën" published in 1724–1726. Apparently he did not think it necessary to give credit to his "brother-in-law and bosom-friend," for he mentioned him only once. It seems that VALENTYN in his "Verhandelingen der dieren van Amboina" [15] "elaborated" or transcribed RUMPHIUS' *Dierboek* in such a way that BURMAN, in 1747, gave up the plan suggested in 1746 for printing the *Dierboek*. His reason was that "I have understood" the manuscript has been "very carefully kept a secret for his nearest relatives and posterity." That VALENTYN made use of RUMPHIUS' observations is, therefore, certain; but it cannot be determined to what extent he did so. Characteristic of VALENTYN's "originality" are the examples which ROUFFAER and MULLER in their bibliography [16] mentioned concerning the birds of paradise as lovers of Tsjampadaha fruits (RUMPHIUS wrote about this in his *Kruidboek* Part I, Book I, p. 109, and added "Whatever is seen and learned later will be given in the *Amboinsch Dierboek*, Part 2," and the "Descriptions of the Serpenticida, or Moncus." Be that as it may, it is certain that RUMPHIUS, in addition to his *Rariteitkamer* (consisting of three books) wrote three other books on "Land-, Lugt-, ende Zeegedierte" intending to combine these to form the *Dierboek*.

Since we know RUMPHIUS' zoological work very incompletely, we should express no opinion of his standing as a zoologist. Yet this judgment, according to the data accessible at this time, must be wholly favorable. The manuscript of the *Amboinsche Rariteitkamer* has descriptions of all kinds of shell-fish (soft and hard); to wit, rare crabs, cray-fish, and such sea-animals as univalve and bivalve mollusks that live in the Amboina Sea. In addition, there are some minerals, rock formations, and species of earths found in Amboina and some neighboring islands."

This manuscript was prepared with the skilful help of Messrs. SIPMAN and RUMPHIUS Jr. in 1699 and sent to one of RUMPHIUS' best friends, Dr. D'ACQUET, the burgomaster of Delft. After receiving this treatise in 1701, D'ACQUET thought it advisable to publish it as speedily as possible, as it might be very useful to the numerous amateur collectors of "Schulpen en hoorntjes" living in our country. Therefore he entrusted the edition to the care of an Amsterdam publisher, FRANÇOIS HALMA, who issued it in 1705. HALMA very wisely called in the help of an expert, SIMON SCHIJNVOET. In his dedication to Dr. D'ACQUET HALMA wrote, "Your Worship, many matters were touched upon superficially by the writer, and necessarily require further elaboration; similarly, some parts were lacking entirely which could not be omitted without impairing the order and arrangement of the study. Time, research, and industry were necessary for this, and we shall not conceal from Your Worship that this could not have been managed without the help and diligence of Mr. SIMON SCHIJNVOET, great critic and lover of these beautiful things, and honored friend of us both. He knows his subject thoroughly and has added not only the missing illustrations, but has enriched the work itself with accurate observations contributing to it much of considerable value." Therefore, in a manner comparable to that with which BURMAN supervised the publication of the *Kruidboek*, the *Rariteitkamer* was improved by SCHIJNVOET's care. In truth RUMPHIUS, living far distant from western science, possessed almost no books on the matter treated in his *Rariteitkamer*, the few which he once had owned had been destroyed by the fire of 1687. Accordingly, the manuscript, as it came from the Indies, was not ready for publication. Here and there it needed to be retouched, completed, and amended so that it would be more in agreement with the style of western works.

The first book of the *Rariteitkamer*, devoted to the "Weeke Schaalvisschen," contained a detailed account of the Crustacea found in the Moluccas. Among these the description of the important Moluccan crab is particularly interesting. Furthermore, he described and illustrated a number of prickly skinned animals: sea-urchins, starfish, basket-stars (medusa-heads), and a few corals. Most representatives of the latter group, however, are mentioned in the twelfth book of his "Herbarium Amboinense." The first book of the *Rariteitkamer* has 54 pages and 16 plates.

As in all of his works, RUMPHIUS here gives no dry descriptions of the species occurring in the Moluccas, but intersperses significant details concerning the life of the animals, their geographic distribution, their use by natives, and so forth. Thus, for instance, the facts which he communicated on the noteworthy occurrence of

attention to the native names of plants, their habitats, abundance, times of flowering, and other data that would be of importance in evaluating RUMPHIUS' descriptive data. (*Translator's Note.*)

[13] P. A. LEUPE, 1871, p. 37, 38.

[14] O. WARBURG, 1897, Die Muskatnuss. Ihre Geschichte, Botanik, Kultur, Handel und Verwerthung, sowie ihre Verfälschungen und Surrogate. Zugleich ein Beitrag zur Kulturgeschichte der Banda-Inseln. Leipzig, 1897, p. 320.

[15] Oud- en Nieuw-Oost-Indiën, Part III.

[16] ROUFFAER en MULLER, 1902, p. 167.

the "Wawo," *Lysidice Oele* R. Horst (*Rariteitkamer* Book I, Chapter 44, p. 51–54),[17] are still highly important for us at the present time. What RUMPHIUS relates on the habits of this species of worm is such excellent proof of his talents of keen observation that I shall dwell on it here.

These worms, even now, two centuries after his time, present some problems. RUMPHIUS described these animals as "small worms, hardly a foot long, sometimes as thick as sail-yarn, nevertheless, mostly as twisted silk, mingled together in little clumps in which one worm longer and thicker than the others is seen; this may be taken for the mother. They are variously colored. Most are dark green, yet there is an undertone of dirty white or yellow, red, brown, and a little blue . . . the one taken for the mother is as thick as the coarsest sail-twine or sometimes a thin pipe, pale yellow or whitish, the little head sticking out of the water, on which can be distinguished two small horns similar to those of snails, and on either side are four distinct little feet like [those of] caterpillars."

In addition to the description of the gross habit, RUMPHIUS presented here a most remarkable phenomenon exhibited by these worms. They come only at definite times — indeed only once a year. "After sunset they float on the water near the shore where they are torn entirely apart, the waves having dashed them against great boulders rising from the sea. By torchlight, they are scooped out of the water with outstretched canvas or fine sieves." [18] And the time at which these animals come to the shore is just after sunset "only the 2nd, 3rd, and 4th evening after the full moon" in February or March, sometimes for three consecutive evenings, or again, if the weather is very hot and dry, for only one evening. This important event, the regular appearance of these worms some days after the full moon, is still an unsolved problem, even two centuries after RUMPHIUS' observation of it. We know that the catch of Wawo was always an occasion for the people to celebrate with a feast, that they were caught between six o'clock in the evening and the rising of the moon, and that they provided [19] for the natives a much-sought-after delicacy. Through Dr. HORST's researches it is evident that the worms themselves are sexually mature at the time of their appearance and that the yearly periodicity is an expression of this growth. But why the animal appears precisely a few days after the full moon is unknown to this day.

The second book of the *Rariteitkamer* fills foliopages 57–166 and treats of the Mollusca exclusively, chiefly the species belonging to the *Gastropoda.* RUMPHIUS' study in this very difficult field shows how an unprejudiced examiner with discriminating powers of observation may have the sagacity to create order out of apparent chaos. With this sense perception RUMPHIUS arranged several genera and families. These were so suitably grouped together that even now his lines of definition are commonly accepted. His nomenclature is frequently very happily chosen.

As a precursor of the binary nomenclature of LINNAEUS, he indicated a number of crustaceans with two names, always a generic name, and then an adjectival one to designate the specific name.

A striking number of new species were described by him. Of the 359 species mentioned in the second book, 157 were still unknown, although there appeared in the course of the seventeenth century a few special works on conchology.[20]

In addition to his contributions in the field of morphology, he showed his scientific propensity by his study of the lives of animals as well as his descriptions of them. He continually informed us what sort of animals live at the bottom of the sea, how they move or how they fasten themselves to the bottom, that sometimes "their color is adapted to the ground" — that is, they take on the color of their surroundings — and similar interesting details. He always discussed the benefits produced by these crustaceans for mankind; he mentioned their nutritive value or poisonous properties, and their geographic distribution over the Molucca Seas in the broadest sense.

Though SCHIJNVOET was an expert, there was one great objection to his elaboration of RUMPHIUS' original manuscript of the *Rariteitkamer.* He added what he considered to be some interesting forms without always paying strict attention to whence they came. All these species were not by any means found in the Indian Ocean; consequently the impression was given that RUMPHIUS had occasionally described shells collected elsewhere as though they had been found in the Moluccas.

Another book, "Beschrijving en Verdeeling der Amboinsche Hoornen en Schulpen," was added by RUMPHIUS' assistant, Mr. SIPMAN. This manuscript was sent to "his particularly good friend, Mr. J. DE JONG" who again referred the treatise to SCHIJNVOET.

With this part filling pages 187–193, the treatment of the animal kingdom is closed. These two books are, therefore, all we know of RUMPHIUS' work in the zoological field. It should be noted here that, in the RUMPHIUS-Gedenkboek, Dr. J. G. DE MAN has provided a key to the Crustacea of the first book,[21] and Prof. E. VON MARTENS has brought together all the invertebrates described in the *Rariteitkamer* identifying them and bringing their nomenclature up to date.[22]

Now it only remains for us to give an impression of RUMPHIUS' importance in the sciences of mineralogy, geology, and paleontology in our colonies. We know of no better way to do this than in the words of Professor WICHMANN as he closed his interesting study of this subject for the RUMPHIUS-Gedenkboek.[23] "The literature forms, as it were, the scarlet thread which binds generations together. In respect to the mineralogical and geological data given in the *Rariteitkamer*, the thread has been broken. For the first time, toward the end of the nineteenth century, the broken ends

[17] R. HORST, 1902: Over de "Wawo" van RUMPHIUS (RUMPHIUS-Gedenkboek, 1902, p. 105–108).

[18] R. HORST, 1902, p. 105.

[19] MAX WEBER, 1899, Bulletin van de Maatschappij tot bevordering van het Natuurkundig Onderzoek der Nederlandsche Koloniën, No. 34, p. 7.

[20] For instance, M. LISTER, 1685–1693?: Historiae sive synopsis methodicae conchyliorum, quorum omnium picturae ad vivum delineatae exhibentur, IV. Londini. 1685–1693?

[21] J. G. DE MAN, 1902: Over de Crustacea (Weeke Schaalvisschen) in RUMPHIUS' *Rariteitkamer.* (RUMPHIUS-Gedenkboek, 1902, p. 98–104).

[22] E. VON MARTENS, 1902: Die Mollusken (Conchyliën) und die übrigen wirbellosen Tiere im RUMPF'schen Raritätkammer (RUMPHIUS-Gedenkboek, 1902, p. 109–136).

[23] A. WICHMANN, 1902: Het aandeel van RUMPHIUS in het mineralogisch en geologisch onderzoek van den Indischen Archipel. (RUMPHIUS-Gedenkboek, 1902, p. 137–164).

were brought together in commemorating the existence of his (RUMPHIUS') book. Thus is shown a rare instance in which a production to-day is still almost as new and important as it was 197 years ago when it was first published. RUMPHIUS owes this prerogative to the accuracy and trustworthiness of his observations, in which characteristic he is unexcelled. By that means he laid a much better foundation than if he had spent his energy trying to work out theories too advanced for the times and as yet incapable of explanation. Again this judgment of him is verified by the fate of so many of his contemporaries. They were famous then, but now one only smiles when their works are examined. The present-day naturalist also respects RUMPHIUS as a pre-eminent leader and predecessor whose work is rightly designated a 'monumentum aere perennius.'" Thus Professor WICHMANN, the noted geologist of our generation, spoke regarding the significance of RUMPHIUS, that lover of natural science who lived two centuries ago.

Even in the study of inanimate nature, then a very difficult and sufficiently fallow field, RUMPHIUS was outstanding. Only the most important of his observations are mentioned here. The most characteristic is his description of the phosphorescence in diamonds, just discovered by BOYLE in 1663. "The diamond has," he says, "a small yet sharply flashing sparkle, not a real spark, but a small fire may be seen in the stone." Again, he gave us a number of communications on the so-called edible earths, which are different species of clay eaten by natives, especially by the women. His service lies particularly in this: his descriptions of the minerals are the first and, up to now, almost the only effort to assemble a topographic mineralogy of our Netherlands East Indies colonies. Naturally, we must scrutinize his information since, at that time, the science of mineralogy was at a low ebb. Minerals, such as diamonds, were considered to be fruits of the earth; they must lie underground a long time before ripening. In truth, we cannot blame RUMPHIUS for having such an opinion.

In contrast to this, his sufficiently adequate idea of the existence and nature of fossils stands out beautifully. Whereas many scholars of Europe still looked at these matters as "lusus naturae" or freaks of nature, RUMPHIUS recognized clearly that they were the remnants of animals. He knew his fossils from nature itself; he found them in the places where they had lain ten centuries, and therefore he obtained a clearer insight into their import than many European research workers who saw them only in museum collections. Thus he recognized a number of fossils as remains of two-valved shells (Lamellibranchiates), or of corals. Single *Ammonites* he connected with the shell of *Argonauta* which he knew.

But, on the other hand, must we find fault with him because he was unable to discover the relationship of the peculiar *Belemnites*, which show no resemblance to any single living organism? And likewise, in perfect agreement with his contempories, he said of *Echinoidea* or fossil sea-urchins, "that they were uniform and thrown there during a large thunderstorm." Although the inaccuracy of this information is now certain, it was then commonly believed.

Moreover, the fact that he spoke of *Ammonites* and *Belemnites* led, not long ago, to most important discoveries of the presence of limestone and chalk formations in the archipelago. The researches were carried out by the Siboga expedition (1899) under the direction of Dr. R. D. M. VERBEEK[24] and of Dr. G. BOEHM.[25]

RUMPHIUS was weakest in the field of true geology where facts are obscure and the treatment is of a more theoretical nature. He appears to have been too much influenced by his staunch belief in the story of creation (Genesis 1), the flood sent in NOAH'S time, and other such biblical stories. Thus he explained the presence of fossil shells on the surface of the land by the flood. It is true that he thought of the possibility of land upheaval through volcanic eruption, but in this case he set no value on it, "for one finds them in the interior of the country on such mountains and on as large islands as without doubt have existed from the beginning of creation." Similarily, his explanation of the eruption of volcanoes was inaccurate; this also may be imputed exclusively to the faulty ideas prevailing at the time.

Although the *Amboinsche Rariteitkamer* was perhaps designed for European lovers of rarities, and the scientific information was not the main point, the work is of great value even for present-day explorers of the Indies. It is most regrettable that the *Dierboek* is not known in the form which RUMPHIUS prepared it. VALENTYN, in whose "Oud- en Nieuw-Oost-Indiën" it is presumably entirely incorporated, lends himself more to beautiful style and the choice phrasing of sentences than to reliability of facts; hence, we must not judge RUMPHIUS' work by VALENTYN'S book.

In addition to these two standard works, the *Kruidboek* and the *Rariteitkamer*, here and there single discoveries of RUMPHIUS have appeared. A number of letters collected by CHR. MENTZEL were published in the "Ephemerides" of the "Academia Naturae Curiosorum" (1693). In this too we find several interesting communications, among others an item on cloves, and one on the phosphorescence of the sea. For the latter phenomenon, also discussed in the *Rariteitkamer* (p. 250) he was unable to find a satisfactory explanation. Moreover, RUMPHIUS corresponded with a number of scholars, particularly in the Indies, Governor-General CAMPHUYS, HERBERT DE JAGER, WILLEM TEN RHYNE, ANDREAS CLEYER and others; then too he wrote a great deal to learned men in Europe. Alas, little is known about RUMPHIUS' correspondence. Rightly it was said in RUMPHIUS' bibliography, "The study that tells how considerably RUMPHIUS corresponded with all kinds of people, learned and otherwise, each person interested, everything for the increase of his knowledge, especially toward the enriching of his *Kruidboek* and his *Rariteitkamer*, . . . this study still must be written and it would be a most interesting work."

Though RUMPHIUS lived in a remote corner of the world deprived of daily intercourse with other scholars, he was not isolated. His exemplary attention to his studies was commonly known, and for this reason on every side people paid him homage. The Noble Directors in their way tried to show how much they appreciated his work. They encouraged him constantly to continue along the path which he had begun, and they were discerning enough to appreciate the excellence of his *Kruidboek*. As we have

[24] R. D. M. VERBEEK, 1900: Voorloopig verslag over eene reis door het oostelijk gedeelte van den Indischen Archipel in 1899. Batavia, 1900, p. 48.

[25] G. BOEHM, 1900: Reise-Notizen aus Ost-Asien. (Zeitschrift deutsch. geol. Ges. LII, 1900, p. 557).

already said, his son Paulus Augustus was promoted to merchant "so as not to allow praiseworthy labor to go unrewarded, and in this way to remunerate provisionally the said Rumphius in some degree."

Scientific circles showed him how very important they considered his pioneer work in the tropics. Probably on the recommendation of his two friends, Cleyer and Mentzel, in 1681 he was elected a member of the "Academia Naturae Curiosorum." According to the curious custom prevailing in that society, he assumed the title "Plinius Indicus." The "cognomen" was certainly aimed at expressing — and the members of the Academy wished by this particularly to express — how very deserving Rumphius' versatile talents appeared. Yet we can rightly commend Du Petit-Thouars when, in his short biography of Rumphius[26] in the "Biographie Universelle," he made the following pertinent remark, "C'était pour cela que, suivant son usage, cette compagnie savante l'a nommé Pline par autonomase; mais il y avait cette différence que Pline l'Ancien avait adopté souvent sans examen ce que ses prédécesseurs lui avaient transmis, tandis que le Nouveau avait vérifié par lui-même tout ce qu'il avait annoncé de plus extraordinaire."

From the previously quoted words of Professor Wichmann and especially from the general concurrence of opinion regarding Rumphius at the commemoration ceremonies organized for him by the Colonial Museum in 1902, it is most obvious that the veneration of scientific men of our time is no less than it was during his lifetime. A number of scholars, botanists, zoologists, geologists, historians, worked together to prepare a Rumphius-Gedenkboek that was creditable, and this Netherlands-German harmony was a great success. Moreover, in his honor a Rumphius-medal was struck off and a Rumphius fund established for the purpose of periodically awarding the medal in gold "to naturalists who are adjudged to have attained great merit for research in the eastern part of the Netherlands Indies Archipelago."[27] For such a land as ours, with so great a source of revenue in the colonies, is it not deplorable that this memorial fund amounts to scarcely fl.7000, half of which is derived from a legacy? How long must this endure before the Netherlands realizes the noble thought of Greshoff: "When once the Moluccas have awakened out of their present lethargy, then there must rise at Hila in Amboina a Rumphius station as a centre for research in the natural history of the much neglected Moluccas?"

In truth, our nation cannot sufficiently honor such a man as Rumphius. In several fields of research he was the pioneer. In the systematic investigation of the flora and fauna of the Indies he established a precedent which few successors have been able to reach or maintain. And there Rumphius worked and wrote with such a modesty and conscientiousness as is, alas, too frequently lacking in scientific students. "All for love, nothing for reward." These are the words that Professor Goebel[28] so fittingly chose as a motto for the *Kruidboek*.

We have seen how Rumphius was encouraged by his studies to leave Europe. It should also be noted that Cosimo de Medici III, grand duke of Tuscany, was interested in him. Proof of this is shown in Rumphius' gift to the duke of the excellent collection of rarities on which he (Rumphius) had worked for many years. One pleasing outcome of the Rumphius' commemoration was the discovery of the documents concerning his relations with Cosimo de Medici III, and also of some natural history objects in the Florence Museum. A large part of this collection, particularly the shells, is at present in the State Museum at Vienna.

The powerful figures of van Reede and Rumphius represent the period of the first flowering of research in the natural history of the Indies. It is noteworthy that it closed the 15th of June, 1702, with the death of Rumphius.

The important development of natural history research in the seventeenth century is therefore chiefly in the field of study of the flora and fauna. Here and there initial efforts were made at research in true biology; whereas, inorganic nature was still little studied. Up to that time no investigations had been made except the very primitive chemical analyses of minerals in Rumphius' *Rariteitkamer* Book III, where much attention is given to whether or not minerals dissolve in lemon juice. Some optical observations also were noted, for instance, about the phosphorescence of the diamond.

Thus the year 1702 saw the end of a period of great productivity, a period of flowering, which in turn was followed by the "sterile" eighteenth century.

*Appendix:* — In the *Biol. Zentralbl.* 43:312–315 (1923), F. Tobler reports on **Rumphius' work and interest in the mangrove vegetation.** This is one of the most interesting of recent Rumphius papers and well worth reproducing.

Die im wesentlichen den Tropen angehoerigen, schon im aeusseren Bild auffallenden Waelder der Meeresufer und Flussmuendungen, die man als Mangrove bezeichnet, sind durch die Fuelle ihrer biologischen Besonderheiten laengst bekannt. Die darin vorkommenden, in die Lehrbuecher uebergegangenen und in den Reisebeschreibungen wiederkehrenden Anpassungen verschiedener Pflanzen an den auffallenden Standort (im Salzwasser oder im Wechsel von Salz- und Suesswasser, im Uferschlamm, im Bereich von Ebbe und Flut) sind namentlich von Karsten[1] grundlegend beschrieben und ebendaher sind die merkwuerdigen Wurzelbildungen von *Rhizophora* u.a. als verankernde Stelzenwurzeln, die nach oben aus dem Schlamm wachsenden Atemwurzeln bei *Avicennia, Brugiera* u.a., die Viviparie der Fruechte und ihre Aussaat bei *Rhizophora* u.a. Allgemeingut der Biologie geworden. Es waere erstaunlich, wenn diese gestaltlichen und standoertlichen Merkwuerdigkeiten nicht schon frueher wenigstens Erwaehnung durch Reisende gefunden haetten: in der Tat pflegt man eines fruehzeitigen Beobachters in der Person G. E. Rumpfs zu gedenken, der mit seinem "Herbarium amboinense"[2] der Systematik als der genaue Beschreiber und Zeichner vieler wichtiger Pflanzenformen von Indonesien und dabei auch derer der Mangrove gilt. So oft er aber erwaehnt und so oft sein Werk mit Andacht angesehen wird, selten scheint der lateinische Text dazu gelesen worden zu sein. Aus ihm aber

[26] L. M. A. A. Du Petit-Thouars, 1825: "Rumpf (George Everard)" *in*: Biographie Universelle ancienne et moderne . . . rédigée par une Societé de gens de lettres et de savants. (Tome 39, p. 317–322). p. 319*a*.

[27] *Cf.* Prelude Rumphius-Gedenkboek, 1902 (p. VIII) and Appendix of the Bulletin Kolon. Museum, No. 28 (p. 12, note).

[28] K. Goebel, 1902: Rumphius als botanischer Naturforscher. (Rumphius-Gedenkboek, 1902, p. 59–62).

[1] Karsten, G., Ueber die Mangrovevegetation im malayischen Archipel. Eine morphologisch-biologische Studie. (Bibl. botan. 21. Cassel 1891.)

[2] Rumpf, G. E. (Rumphius), Herbarium amboinense. Nach dem Tode des Verfassers († 1702) herausgegeben und mit Register versehen von B. J. Burmann. (Amsterdam 1741 1755 in 6 Foliobaenden.)

kann man neben den unbestrittenen Werten fuer die Systematik und Pflanzengeographie mehr als bisher bekannt auch Stoff fuer die Biologie und Oekologie schoepfen. An dem besonderen Fall der Mangrove zeigt sich dabei, dass er darin so sorgsame Beobachtungen gab, die ueber den Rahmen des typischen Mangrovebildes hinaus schon das erlaeutern, was erst neuerdings als Abweichung davon erkannt und als bemerkenswert fuer Entwicklung der Pflanzenformation und die Erhaltung der alten Anpassungsmerkmale auch ausserhalb des typischen Standorts beschrieben worden ist.

Welche Arten in den Beschreibungen RUMPFS vorliegen, ist uns heute einwandfrei bekannt.[3] Es ist daher moeglich, sich unmittelbar an seine Beschreibungen zu halten. Schon in der Vorrede erwaehnt RUMPF unter den besonderen Merkwuerdigkeiten: Baeume, die aus den Aesten Wurzeln zur Erde senden, wie Mangi-Mangi oder *Mangium Candelarium*, womit nach uebereinstimmender Ansicht der Haupttyp der Mangrove *Rhizophora Mangle* gemeint ist. Kap. 61 heisst es hierueber (uebersetzt): "Der Baum hat einen kurzen Stamm, gekruemmt und unregelmaessig, der sich unterwaerts in mehrere schwarze dicke Wurzeln teilt, die sich wie Bogen ueber die Erde erheben, so dass der eigentliche Stamm nicht erstiegen werden kann. Oberwaerts aber teilt sich dieser derart in gleichfalls gekruemmte und weit ausgebreitete Aeste, dass manche Baeume nicht anders aussehen wie eine Masse von Aesten und Wurzeln ohne Stamm . . . Von den Baeumen haengen grade seilartige Gebilde herab, senkrecht, wenn sie frei haengen. Sie teilen sich ueber dem Boden, treiben Wurzeln, sobald sie ihn beruehren und steifen sich dann wie ein gedrehtes Tau und wachsen allmaehlich zu Aesten aus. . . . Bis zweieinhalb Fuss lang haengen die kerzenstarken Fruechte herab. Haengen sie tief oder fallen sie herunter, so treiben sie Wurzeln und wachsen zu Baeumen heran. Werden sie von der Flut weggetragen, so keimen sie anderwaerts." — Hierin ist — ungewoehnlich fuer jene Zeit der Naturbeschreibung — auf das klarste schon die biologische Besonderheit, die uns durch die neueren Beobachter zum klassischen Beispiel wurde, enthalten. Um so verwunderlicher erscheint zunaechst daneben die Standortsangabe: "Der Baum waechst auf harten Boeden, auf denen kein oder wenig Schlamm vorkommt, abgesehen von der Stelle, auf der der Baum mit seinen Wurzeln befestigt ist, wo man auch eine Art Grube oder Behaelter, gefuellt mit Wasse und Schlamm, wahrnimmt, an deren Grund sich indess bald der harte Stein- oder Korallenboden vorfindet. Der Standort des Baumes wird von Ebbe und Flut beruehrt, doch findet er sich auch an Stellen dauernden Wasserstandes, so dass der Baum foermlich mit dem Meere um die Herrschaft ueber das Land kaempft. . . ." Der genaue Fundort fuer Amboina ist eine bestimmte Flussmuendung, daneben wird die Guianakueste verzeichnet.

In diesen Angaben muss dem Biologen von heute die ausdruecklich betonte Schlammlosigkeit des Standortes fuer die meist in Massen auftretenden Pflanzen auffallen. Die herrschende Ansicht setzt fuer die Eigenart des Mangrovebaumes bei Keimung, Bewurzelung und Anheftung gerade den Schlammboden voraus! Das bestaetigt ein Blick in die Reisebeschreibungen der heutigen Naturforscher.[4]

RUMPF hat aber trotzdem wohl recht: er hat ein nicht allzu grosses Gebiet seinen Beobachtungen zu Grunde gelegt und mit beispielloser Genauigkeit beschrieben. Fuer seine *Rhizophora Mangle* hat er solche Stellen im Auge gehabt, wie sie neuerdings als Abweichungen von mir fuer eine ostafrikanische Mangrove beschrieben worden sind.[5] Phylogenetisch ist allerdings der Schlammstandort als der bezeichnende fuer die Form und Eigenart anzusehen, so wie er auch heute noch fuer das "Schulbeispiel" des Mangrovebaumes zu gelten hat. Siedelt sich die Pflanze aber auf Standorten an, die sozusagen nicht mit dem Typus "stimmen," so geht, wie ich zeigte, auch die Bewurzelung andere Wege: Das Einbohren wird z.B. durch das (gelegentliche) Einsenken in die Loecher der rezenten Koralle ersetzt, die Adventivwurzeln greifen krallenartig in solche Loecher ein, verzweigen sich also oberhalb des Bodens (und nicht im Schlamm); nur bei sinkendem Wasser kann daher die Ansiedlung der Keimlinge erfolgen, die dank ihrer (sonst bekannten) senkrechten Schwimmlage eben in die Loecher gelangen und Moeglichkeit zur (eiligen) Bewurzelung finden. Auch mir ist bei Abfassung meiner Studie 1914 der Text des RUMPF unbekannt gewesen. Gern erblicke ich darin heute eine Bestaetigung meiner Beobachtungen, dass die typischen Mangrovevertreter auch auf abweichendem Standort vorkommen.

Fuer RUMPFS Sorgfalt mag weiter zeugen, dass er bei "Mangium minus" (*Ceriops Candolleana*) das Vorkommen an ruhigeren Standorten erwaehnt, was heissen wuerde: an schlammreicheren. Von dieser Art beschreibt er auch das Einbohren der reichlich vom Baum herunterhaengenden Fruechte in den Boden ganz ausdruecklich, doch vermisst er die Art auf Amboina! Das passt vorzueglich zu dem uebrigen: auf Amboina ueberwog eben der weniger schlammreiche Untergrund fuer die Mangrove, die er kannte. Es fehlt daher auch *Ceriops*, fuer die ich gleichfalls diesen Gegensatz zu *Rhizophora* beschrieben habe.

Und endlich diene als drittes Beispiel zu dem Gegenstand die vorzuegliche Beschreibung des Wurzelsystems von "Mangium caseolare" (*Sonneratia caseolaris*), die bekanntlich der Stelzenwurzeln und — wenigstens fuer gewoehnlich — anderer auf dem Boden kriechender entbehrt. Von ihr heisst es Kap. 62: "Der Baum hat keine schlangenartigen Wurzeln, aber weit um den Stamm herum ragen aus dem Boden zahllos spitze Hoerner auf, eng beieinander, dass man kaum den Fuss dazwischen setzen kann. Sie fehlen nur unmittelbar am Stamm und sind desto groesser, je weiter ab vom Stamm und je mehr im Wasser. . . . Sie kommen stets am Baum vor, nie ohne ihn. Wurzelsprosse koennen es nicht sein, weil sie nah am Baum Fehlen, wo die Wurzeln entspringen. Graebt man sie aus, so findet man sie allenthalben auf dem steinigen Untergrund, bis zwei Fuss lang und einen Fuss dick. In der Mitte gehen von ihnen Querstraenge aus, deren staerkste mit den Hoernern in Verbindung stehen, diese sind den dicken Wurzeln aufgesetzt." RUMPF hat ersichtlich das horizontal auf dem Steinboden liegende Wurzelsystem mit den bei *Sonneratia* knotig verdickten aufrechten Atemwurzeln offen vor sich gehabt und die morphologischen Zusammenhaenge klar erkannt. Auch hier ist die Ausbildung des ganzen Systems — wenn es auch unter einer maessigen Schlammschicht, aber eben doch auf dem Felsen fest auflag — dieselbe, wie ich sie fuer diese Form als wesentlich und vom "Schema" abweichend in der Mangrove auf nicht schlammigem Boden geschildert habe. Dass hier bei dem fruehen Beobachter das Verstaendnis fuer das Wesen der Atemwurzeln fehlte, ist dafuer belanglos.

Einen Gegensatz zwischen der Ausbildung auf Stein und Schlamm hat RUMPF selbst nur an einer Stelle erwaehnt: fuer "Mangium celsum" (*Brugiera gymnorrhiza*) gibt er in Kap. 58 an, dass die Wurzeln im Schlamm weich und schwammig, ueber ihm hart (zum Draufgehen) sind und ihre eigentliche Verankerung in dem under dem Schlamm liegenden Korallenboden finden. Er setzt diese Ausbildung in Gegensatz zu der auf Sand, wo die Wurzeln rasch in den Boden dringen. Mit der Behauptung, dass RUMPF fuer seine, wenngleich so ausgezeichneten Mangrovebeobachtungen nicht eigentlich die typischen Standorte zur Beobachtung gehabt habe, stimmt noch besonders gut das Fehlen der Beschreibung von Atemwurzeln bei "Mangium album" (*Avicennia officinalis*) in Kap. 63. Er fuehrt an, dass der Baum nur niedrig bleibe, an flachen Ufern, auf trocknerem Boden mit kleinen Steinen sich vorfinde. *Avicennia* ist naemlich ein so ausgesprochener Sand- und Schlammbewohner, dass sie auf den Standorten der anderen "Mangibaeume" nicht fortkommt und an den Stellen, wo sie RUMPF in der Naehe sah, nur wenig und nicht typisch entwickelt war.

Diese Beispiele moegen nicht allein eine Bestaetigung meiner fruehern Mangrovebeobachtungen bilden, so wie sie das Urbild aller, auch der typischen Mangroveschilderungen sind, sondern sie moegen vor allem auch zeigen, dass der anerkannte Florist und Reisende ein seiner Zeit weit vorausgeeilter Biologe war. Goebel[6] sagt mit Recht von ihm: "Ihm waren die Pflanzen noch nicht das Material, aus dem man Herbarexemplare praeparieren kann, die dann eigentlich erst der Untersuchung wert sind, er sah sie als das an, was sie sind, als lebende Wesen."

[3] HASSKARL, J., Neuer Schluessel zu RUMPFS Herbar. (Abh. d. Naturf-Ges. Halle IX. 1866.)

[4] Z. B. HABERLANDT, G., Eine botanische Tropenreise 2. Aufl. (Leipzig 1910) S. 180 ff. GUENTHER, K., Einfuehrung in die Tropenwelt (Leipzig 1911) S. 231 ff.

[5] TOBLER, F., Die Mangrove der Insel Ulenge, Deutsch-Ostafrika. Englers Botan. Jahrb. 50, Festschrift fuer A. ENGLER. 1914. S. 398 ff.

[6] GOEBEL, K., RUMPHIUS als botanischer Naturforscher. (RUMPHIUS-Gedenkboek. Haarlem 1912.) S. 59.

# MEDICAL CONTRIBUTIONS FROM THE NETHERLANDS INDIES

*by*

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**Introduction.** — Between 1595 and 1600, Netherlanders made their first voyages to the East Indies. In 1602, the several small navigation companies that had been competing with each other were merged into a single concern, the East Indies Company, which was entitled to establish fortified places in India, to exercise the right of suzerainty, and to conclude treaties with the oriental rulers. The activities of this Netherlands East Indies Company extended over a large colonial territory which ultimately developed into the Netherlands Indies. This empire has been curtailed in the course of years, especially by the English who, during the Napoleonic Wars in Europe, temporarily occupied the Dutch possessions and who, in 1816, returned only part of them. Even so, a large territory belonged to Holland — until the Japanese temporarily overran it in 1942.

Thanks to careful studies of the history of the East Indies Company made by competent authorities (1, 2), we are well informed about the development of curative and preventive medicine in the Netherlands East Indies. As long as the Netherlands East Indies Company existed — that is between 1600 and 1800 — most of the medical service both on the ships and in the Netherlands East Indies proper was entrusted to the care of "surgeons". The student-surgeons in Holland were educated by the Guilds. Their years of apprenticeship were passed in the shops of the Guild, that is, in the barber shops. A candidate had to pass certain tests or examinations before he was admitted as master surgeon.

At the beginning of the sixteenth century, this examination consisted of the grinding of three crude pieces of iron into bleeding scalpels. With these "instruments" some test bleedings were performed on volunteers who received a remuneration of money plus an invitation to a merry Guild dinner at which the candidate's success was celebrated. After standing the test, the young master was entitled to open a shop and to hang up the barber's brass basins, which served not only as a sign-board but as a vessel for the exhibition of the blood drawn during venesections.

In the course of the centuries, this Guild examination was extended and became more and more purely medical. From the outset the East Indies Company did not accept the guarantees made by the Guilds, and the surgeons sent out by the Company had to pass an additional examination which was conducted by the medical experts of the Company. It should be stressed, that except for these surgeons, very few doctors belonged to the medical personnel of the Company. Of every hundred surgeons sent out by the Company, only three were medical doctors. This condition may be thought strange because, in the Netherlands proper, the surgeons were strictly forbidden to treat internal diseases, which remained completely within the province of the physician. However, as soon as they entered the Company's service, these same surgeons were charged with all medical duties, both on board and on shore in India. It is certain that, at the time, the population of the Netherlands was too small to provide a sufficient number of well-trained doctors for the Company's service. Furthermore, only a small percentage of the learned *doctores medicinae* were willing to leave the safety of the home country for the jungles of the tropics.

By the late eighteenth century, the Company continually employed three hundred surgeons. At one time, one hundred and seven surgeons were distributed over the whole archipelago to tend the sick people and to take care of the military garrisons. About a hundred were working on the ships sailing between Holland and the Indies. Another hundred were established on the ships plying between the different islands of the archipelago, and also in the offices of the Company in the Cape Colony, Ceylon, Near India, and Japan.

In 1800, the East Indies Company was dissolved. Between 1795 and 1800, because of the strict blockade imposed by England, no ships from Holland had reached the Indies. In 1795, the British took the offices of the Company at the Cape, Near India, Ceylon, Malacca, the West Coast of Sumatra, Amboina, and Banda into custody. In 1811, the English conquered Java and the rest of the archipelago. This occupation by the English was, however, only temporary; after NAPOLEON had been conquered, in August 1816, the Netherlanders were solemnly reinstated as rulers of the Netherlands East Indies.

Gradually a new administration was built up. In 1826, the Civil Medical Service, the Military Medical Service, and the Vaccination Service were united under a single direction. For many decades, the Army Medical Corps took care of the Public Health Service of this large area, and the Chief of the Army Medical Corps was also

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

Chief of the Public Health Service. This arrangement was not changed until 1911. That year, a Civil Medical Service, which was transformed into the Public Health Service in 1925, was organized. The last change in title had a deep significance. It indicated that, whereas in 1911 the Medical Service was designed mainly to provide curative medicine to the inhabitants of the archipelago, the Public Health Service would now give special attention to the prevention of disease.

Several institutions which have played important parts in the development of medicine and public health in the Netherlands East Indies were organized. In 1876 there was opened in Batavia a medical school for Indonesian physicians. In 1913 a similar school was started in Soerabaja. The school in Batavia was reorganized in 1927. Since then, medical education there has been equal to that in one of the medical schools of a university in the Netherlands; requirements for admission to either were the same. The diplomas, licenses, and grades of the school in Batavia were valid in the Netherlands, and its graduates had the right to practice in the mother country.

The course of study in the school at Soerabaja was gradually extended until it required eight years for completion. The study of medicine took five years; the first three years were only preparatory. Having received their final diplomas, candidates were qualified to practice medicine, surgery, and obstetrics; but their field of activity could be only the Netherlands East Indies. They held the title of Indonesian Physician. Incidentally, these Indonesian physicians were excellently trained men who have made notable contributions to the development of medicine in the archipelago.

At Batavia there was also a school for the training of Indonesian dentists.

Several laboratories were found on the different islands. They were as follows:

1. Government Smallpox Institute at Batavia.
2. The Central Laboratory of Public Health Service, founded in 1888 in Batavia, recently designated the Eijkman Institute.
3. The Regional Laboratory for Middle Java in Semarang.
4. The Regional Laboratory for Eastern Java in Soerabaja.
5. The Regional Laboratory for Celebes and the Moluccas in Macassar.
6. The Laboratory for Technical Hygiene in Bandoeng.
7. The Institute of Nutrition in Batavia.
8. The Laboratories of the Malaria Service in Batavia and Soerabaja; the Leprosy Laboratory in Semarang.
9. The Pathological Laboratory of the large plantations of Sumatra's east coast in Medan.
10. The Veterinary Institute in Buitenzorg.

Medical science in the Netherlands East Indies has also greatly profited by the publication of several periodicals. The first, "Het Natuur- en Geneeskundig Archief," was started in 1844 but ran only until 1847. Another, "Het Geneeskundig Tijdschrift voor Nederlandsch-Indië," appeared in 1851 and ran without interruption until 1942 (4). In later years, this journal came out every week; earlier, only once in two weeks. Anybody who wants to study the development of medical science in this area will find full information in the interesting volumes of this excellent publication. Supplementary material is found in the "Mededeelingen van den Dienst der Volksgezondheid van Nederlandsch-Indië" (Communications of the Public Health Service of the Netherlands Indies) which contain the scientific contributions of the staff members of the Public Health Service. Each year since 1912, a good-sized volume, full of important information, has appeared. In addition, special journals on physics and biology, on ethnography, on botany and zoology, on the veterinary sciences, and so on, indicate the high level of scientific work in this area.

The opening of so many institutions of higher learning and of scientific research shows that the authorities responsible for the government of the Netherlands Indies always tried to remain abreast the development of scientific medicine in the home country.

**Smallpox Vaccination.**— The early introduction of the cowpox vaccination in the archipelago requires a special discussion (1, 2). JENNER's book on vaccination was published in 1798. Vaccination was started in the United States in 1800. It was introduced in the Indies in 1804. However, political influences rather than active interest in preventive medicine were instrumental in the timely introduction of this important practice in the Indies.

In 1804, thanks to the assistance of the French, who were then in possession of Mauritius, the first vaccine reached the Netherlands East Indies from this island. Late in 1803, the lieutenant general of Mauritius sent a man-of-war to Batavia. This vessel carried a letter from the governor of Mauritius to the governor-general of the Indies extolling the excellent results of cowpox vaccination which had recently been introduced on Mauritius. This letter was accompanied by a considerable quantity of vaccine. Unfortunately, because of the prolonged voyage, the vaccine proved to be inactive.

The governor-general of the Indies then sent a ship from Java to Mauritius with ten or twelve healthy children, who had never been touched by smallpox, on board. One of these children was vaccinated after their arrival in Mauritius, and the vaccine was kept alive during the voyage from Mauritius to Batavia by successively vaccinating the other children, each with seven to ten days' interval. This method of sending a ship with a cargo of healthy children to keep the vaccine alive during a long sea journey was first used by Spain in 1800 to transport living vaccine from Europe to Central America and South America, from whence it was transported in the same way to the Philippines, Macao, and Canton (5).

How much political circumstances furthered the speedy introduction of vaccination in the Indies is illustrated by a letter forwarded in 1805 by the English commander of the west coast of Sumatra to the governor of the Netherlands Indies. The English governor, like his French colleague, advocated the introduction of cowpox vaccination to Java; he too sent a phial of vaccine and instructions for its use.

The reasons why not only the French, but also the English, were anxious to offer even unasked assistance to the Netherlands Indies in the campaign against smallpox on Java were political. There were many French auxiliary troops on Java in those years when the Netherlands proper were occupied by the French. On the other hand, the English expected to take over Java within the near furure — and did so, as a matter of fact, seven years later. Evidently

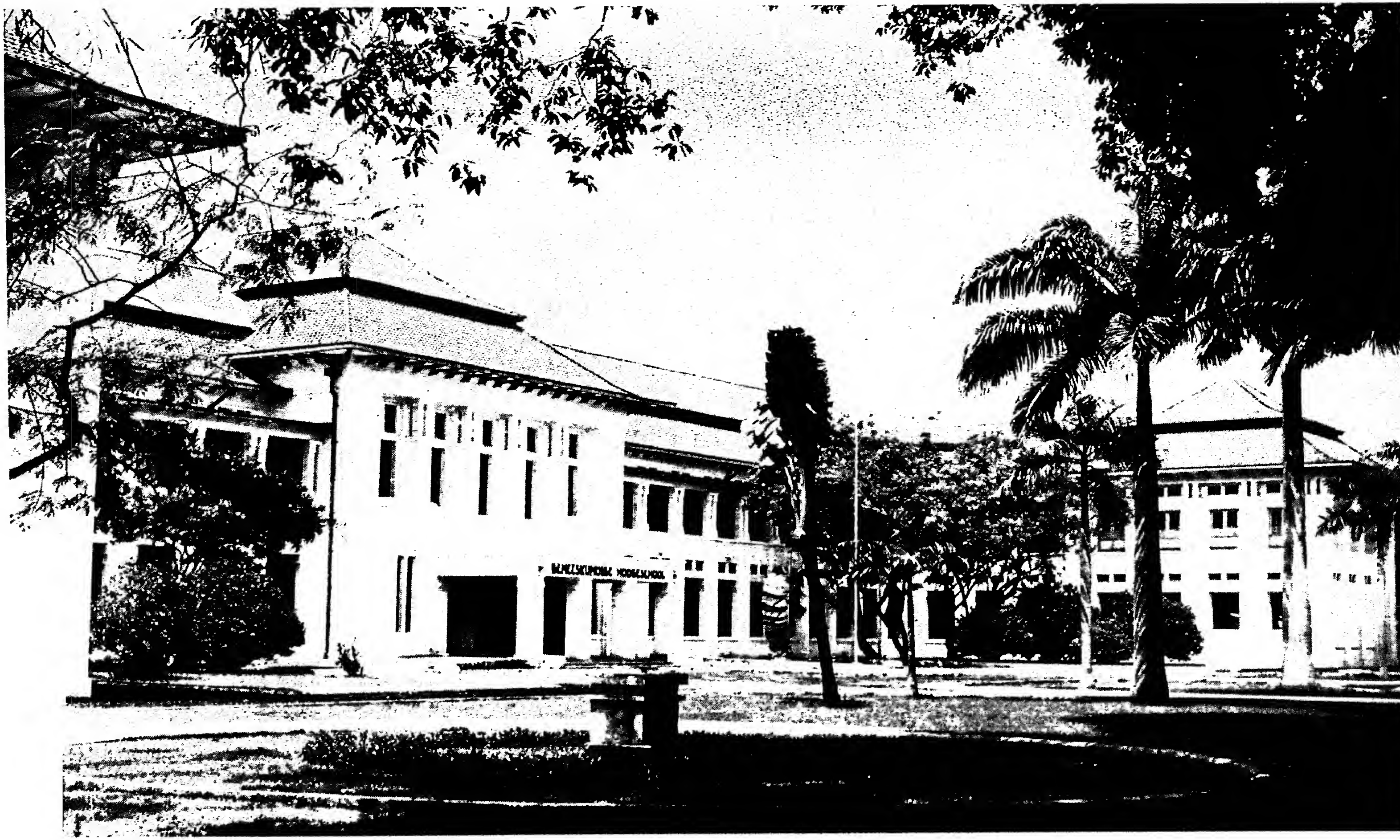

FIGURE 79. — THE COLLEGE OF MEDICINE IN BATAVIA. — *Courtesy Netherlands Information Bureau, New York City.*

both the French and the English wanted to protect their troops in this area by preventing smallpox among the population, and the similar ideas were mutually concealed in an exchange of polite inanities accompanying the phials of cowpox vaccine. Anyway for once public health was furthered by international politics, and since 1804 smallpox vaccination has been popular in the Indies.

Ultimately, it has even become possible practically to eradicate this disease from this area, where formerly serious epidemics occurred regularly. The last large outbreak of smallpox was reported on Java in 1913. Smaller outbreaks happened in 1918 in Batavia, in 1919 in Bandoeng, and in 1922 in Semarang. In 1924, the last epidemic on Java was observed in Soerabaja; and in 1929, the last small epidemic occurred in certain areas of the Outer Provinces. Since 1929, smallpox has practically disappeared from the Netherlands East Indies. In 1937, there was one case reported from Java and none from the Outer Provinces. In 1938 these figures were 9 and 3 respectively. Extensive vaccination and revaccination campaigns had been organized with great skill. Each year one and a half to two million vaccinations (2,101,669 in 1939) and four to six million revaccinations (5,694,199 in 1939) had been performed regularly (6). Since 1926, a dried vaccine stored under anaerobic conditions, as manufactured by OTTEN, had been used exclusively.

**Scientific Contributions.** — In addition to the organization of an efficient Medical and Public Health Service, the medical corps of the Netherlands Indies can with pride look upon its scientific research which in several fields has led to important and original discoveries. Here follows a short discussion of the original research which has been performed in the Netherlands Indies in the field of beri-beri, malaria sanitation, amebiasis, cholera, plague, leptospirosis, and filiariasis.

*a. Beri-Beri.* — Even at the beginning of the control of the East Indian Company, a few famous physicians had reached the Netherlands East Indies and made valuable contributions. In this connection, JACOBUS BONTIUS must be mentioned (1, 2). Although he stayed in Batavia only between 1627 and 1631, the year of his death, in this short period he made many important observations.

He carefully described beri-beri and frambesia. As far as frambesia was concerned, BONTIUS stressed the similarity of this disease with the Spanish pox or syphilis. On the other hand, he had discovered that the disease was contracted without sexual intercourse and therefore had to be distinguished from genuine syphilis.

Beri-beri had been mentioned in 1611 in official reports from the lay governor-general to the head office of the East Indian Company in Amsterdam. The first careful medical description of the disease, however, was made by BONTIUS, who reported that the name "beri-beri" was derived from the Malayan word "biri biri," which means sheep. Evidently the gait of the patients with polyneuritis reminded the Malayans of the way a sheep walks. As early as 1660, RUMPHIUS, "the blind seer of Amboyna," a merchant who was highly interested in the fauna and the flora of the archipelago, reported that beri-beri could be cured by the administration of the mungo beans, katjang idjoe, a bean which even in modern times is frequently used for the same purpose with great success.

Another article in this journal deals in more detail with the later contributions from the Netherlands Indies which eventually solved the beri-beri problem. First may be mentioned EIJKMAN's discovery that chickens fed white rice developed a polyneuritis resembling beriberi which could be cured and prevented by handpounded rice and by silver fleece rice. The ultimate solution of the beri-beri problem came from the same laboratory in Batavia where EIJKMAN had worked, when in 1927 JANSEN and DONATH reported the isolation of crystalline vitamin $B_1$. EIJKMAN's experimental chicken polyneuritis not only showed the way to the practical and scientific solution of the beri-beri problem, but EIJKMAN's investigation started the development of the science of vitamins.

*b. Malaria Control.* — After it had become known that anophelines were the carriers of malaria, efforts to control malaria were made by measures intended to inhibit the breeding of these mosquitoes. It soon appeared that measures instituted with the intention of preventing the breeding of mosquitoes often increased considerably the number of anophelines and thereby the incidence of malaria. The classical triade of anti-malaria measures — "clearing, filling and draining" — was sometimes successful; but on other occasions these same measures led to disastrous results and to dangerous malaria epidemics. In the Netherlands Indies scientists soon understood that in order to organize a rational malaria campaign they must first study carefully the special anophelines which were responsible for the transfer of malaria in the area from which the insects were to be cleared. Measures which had a salutary effect in one region were disastrous in another because the ecology of the anopheline transmitters varied. In this way, species sanitation, based on the idea that the sanitation of a malarious area depends completely upon the specific customs and qualities of the species of anophelines which are the vectors in this special area, was born (7, 8). Originally devised by SWELLENGREBEL, species sanitation has been the cornerstone of the malaria campaign in the Netherlands Indies and has been perfected by many malariologists who have worked there (SCHÜFFNER, VAN BREEMEN, WALCH, OVERBEEK, VENHUIS, STOKER, MANGKOEWINOTO, SOESILO and others) (9).

As an example, the species sanitation of the coasts of many of the islands of the archipelago can be mentioned (10). The geomorphic situation of the south coast of Java, the west coast of Sumatra, the coast of many of the Lesser Soenda islands and of the Moluccas is such that malaria must result. Here the combination of the strong east-west current along the coast and the heavy surf leads to the gradual but continuous displacement of the river mouths towards the west and to the formation of deltas with many brackish water lagoons.

Another factor leading to delta formation at the river mouths is connected with the dangerous deforestation of the hills in Java. Without the trees, the soil is no longer able to hold and conserve water, and during the wet monsoon all the rain water runs to the sea in the swollen rivers. In the dry season, however, many rivers dwindle to insignificant trickles. This small

volume of river water allows the sea currents to deposit large quantities of silt in the old river mouths. When the next wet monsoon arrives, the water collects behind the silt bar and forms a lagoon. These salt water lagoons are ideal places for *Anopheles sundaicus* which, although not a malaria carrier in other parts of the world, is one of the most dangerous malaria vectors in the Netherlands Indies. Sanitation of these lagoons is difficult. Applications of oil and of Paris green are not very effective because the strong winds sweep these preparations to one side. Only if the lagoons can be so opened into the ocean that the tides can enter freely is the anopheles breeding stopped. Where this is impossible, the population must choose dwellings several miles away from the lagoons in order to be safe from malaria.

Contrariwise, there exists in the East Indian archipelago another coast configuration which almost eliminates the dangers of malaria. The mangrove forests along the coasts of Borneo, Sumatra, part of the north coast of Java, and also of a few small islands of the archipelago seem to form a safeguard against malaria infection. This must be connected with the fact that mangroves grow only on coasts where the differences between high and low tide are considerable, a condition which prevents the breeding of anopheles larvae. The cities of Palembang on Sumatra, Pontianak, and Bandjermasin on the mangrove coasts of Borneo are built on the marshy banks of large rivers. Between the houses and streets are found many malodorous narrow canals. Although these poor hygienic conditions might be considered favorable for the spread of malaria, these cities are nearly malaria-free because they are built near the mangrove shores, where the high tide reaches far inland along the broad rivers. The settlers in these mangrove areas were evidently taught by practical experience and have constructed the canals in the cities mentioned in such a way that they do not interfere with the free entrance of the tide. However, as soon as the mangrove forests are touched, serious dangers result. Felling even a small part of the mangrove trees is dangerous, because around the dead stumps irregular patches of marshy land are formed, often above the tide mark, where anophelines can breed. Furthermore, exploitation of the mangrove forests is always connected with the building of roads and dykes which hinder the free entrance of the tide; saltwater lagoons, where *A. sundaicus* can breed, result. When houses must be built on a mangrove coast, a stone dam between the mangrove forest and the tidewater area must be erected in order to maintain the tide differential in the mangrove forest.

These facts explain also why the saltwater fish ponds which the population often digs near the coast are frequently dangerous hotbeds for malaria. In some places, before malaria can be eradicated, it has been necessary to stop this culture of fish in saltwater lagoons by making a wide opening between the lagoons and the ocean.

Rice sawahs are dangerous when algae are allowed to grow amidst the rice. This means that especially sawahs which are not drained after the rice is harvested become breeding places for malaria mosquitoes, partly for *A. sundaicus*, partly for *A. aconitus*. In many areas of Java, the population uses part of the irrigated rice sawahs as freshwater fish ponds. Again these freshwater fish ponds are breeding places for malaria anophelines. Only periodic drying of these fish ponds, to destroy the algae vegetation, is able to diminish the malaria danger.

Man-made malaria, especially occurs when the malaria vectors are typical sunbreeders. Of these, *Anopheles maculatus*, *A. punctulatus punctulatus* and *A. punctulatus moluccensis* are most frequent. *A. maculatus* occurs everywhere in the Greater and Lesser Soenda islands — in the hills as far up as 4,000 feet. Here *A. maculatus*, together with *A. minimus*, is one of the most important vectors. *A. punctulatus*, especially the *moluccensis* variety, is an extremely important vector in Dutch New Guinea and in most of the Moluccas. In all these areas, the felling of trees results in malaria outbreaks, unless the cleared area is simultaneously carefully drained. This is often not too difficult in the *A. punctulatus* areas. *A. maculatus*, however, breeds by preference in the running water of brooks and small rivers. In *A. maculatus* areas, it may therefore be necessary to transform the brooks into subterranean streams before the danger of malaria can be controlled. In all areas where sunbreeders are present no clearing of trees should be allowed unless it can be immediately combined with careful drainage.

These examples may show how the malariologists of the Netherlands Indies have pioneered in the control of malaria by studying the ecology of the malaria vectors, that is the species sanitation.

Just before the occupation by the Japanese, new investigations from the Netherlands Indies revealed ways in which species sanitation could be still further improved. Until then, adult female anophelines caught in stables and houses had been dissected to determine which anophelines were the active vectors in a special area. After the anopheles species which acted as vector had been determined, species sanitation could be started. For certain anopheline species which bit especially by night, it was even necessary to organize catches in the houses between 10 P.M. and 2 A.M., a task which caused considerable discomfort to both catchers and residents.

Lately VENHUIS (11) has demonstrated that the infected female specimens of *Anopheles maculatus*, *A. aconitus*, *A. minimus*, *A. minimus flavirostris* and *A. leucosphyrus* are found in considerable numbers during the daytime at the stream banks. Future careful searches of these banks may well reveal that, in certain localities, one of these four species acts as vector, although all had previously been considered innocent, as a result of the knowledge obtained from the dissection of specimens caught in stables and houses. These results demonstrate how, until the days of the Japanese invasion, the methods of species sanitation in the Netherlands Indies were continually being improved by indefatigable scientific research.

*c. Amebiasis.* — The knowledge of pathogenic amebae has gradually developed since 1893 when QUINCKE and ROOS demonstrated that in human stools two kinds of amebae occurred, one of which was pathogenic, and the other one harmless. In 1903, SCHAUDINN made the same differentiation and further distinguished between pathogenic *Endameba histolytica* and non-pathogenic *E. coli*. Gradually, other amebae were described. But in 1912, HARTMANN demonstrated that *E. tetragena*, *E. africana*, *E. nip-*

*ponica* and *E. histolytica* were identical. In 1912, DARLING reported that, before cyst formation sets in, the normally shaped dysentery amebae disappear and are replaced by small amebae, identical with the *Endameba minuta* which several years before had been described by ELMASSIAN as a separate species.

In the meantime, the complete life cycle of the *E. histolytica* had remained obscure. In 1913, KUENEN and SWELLENGREBEL studied this problem carefully in Deli, on Sumatra's east coast (12). They could demonstrate that two phases in the vegetative cycle of *E. histolytica* have to be distinguished: a first phase when the ameba is a tissue parasite and lives in the ulcerated intestinal mucosa or in the liver; a second phase when the ameba lives saprophytically in the stool. In microscopic preparations of the ulcerated intestinal wall only vegetative forms, but never cysts, are found. Experimentally it has also been impossible to coax these large vegetative forms into cyst formation; as long as *E. histolytica* is a tissue parasite, it remains in the vegetative stage of its development. When ultimately the ulcers heal, the dysentery amebae are obliged to live on the intestinal wall and to start a saprophytic life. This results in the formation of the minuta form of the *E. dysenteriae* which, as mentioned already, are identical with ELMASSIAN'S *E. minuta*.

The third stage of the *Endameba dysenteriae* is the transformation of the saprophytic *E. minuta* into cysts. Unripe cysts are uninuclear; ripe cysts, quadrinuclear. In this way the life cycle of the *E. dysenteriae* pivots around the minuta form. Whenever a person is infected with amebic cysts, first minuta forms appear in the intestinal contents. These minuta forms may invade the enteric wall, develop to the full-grown *E. dysenteriae*, and cause the characteristic ulceration; or the minuta forms may remain saprophytes, living on the intestinal mucosa, and give rise to the formation of cysts which can be found in the stool.

*d. Cholera.* — Until 1920, cholera epidemics had to be reported every year from the Netherlands East Indies. On Java and Madoera alone, the following number of cholera deaths were reported between 1910 and 1920 (13).

*Cholera Deaths on Java and Madoera*

| | |
|---|---|
| 1910 | 64,733 |
| 1911 | 6,939 |
| 1912 | 4,575 |
| 1913 | 1,562 |
| 1914 | 1,108 |
| 1915 | 1,144 |
| 1916 | 1,199 |
| 1917 | 327 |
| 1918 | 9,864 |
| 1919 | 9,818 |
| 1920 | 17 |

Since 1921, thanks to careful quarantine measures and extensive vaccination, the Netherlands East Indies had been free from cholera apart from a small explosion of 9 cases — imported from Singapore — at Batavia in 1924. Between September 1937 and July 1940, however, a small cholera epidemic developed in some native hamlets situated along the coast of southwest Celebes and somewhat inland in the government districts of Pangkadjene, Gowa, Barroe, and Maros. Cases also occurred on three of the small islands of the Spermonde archipelago off the Celebes coast about forty miles north of Macassar, and two cases occurred in Macassar itself.

The infected coastal margin north of Macassar narrowed toward the north and was intersected by six small rivers and several brooks. It was bounded by the highway from Macassar to Pare Pare, from which two by-ways and some paths led into the hilly country and the limestone mountains beyond. The infected coastal strip south of Macassar was bounded by the highroad from Macassar to Takalar.

The Spermonde archipelago consists of some fifty mostly inhabited islands situated on a triangular reef stretching about thirty-five miles into the ocean. The populations of the different islands varies from a few to two thousand inhabitants. The whole of the Spermonde archipelago has about twenty thousand inhabitants. At the time of the west monsoon the coastal region is for the greater part flooded; during the east monsoon the soil is cracked. The communications in the coastal areas are kept up by means of numerous motor bus services over a long distance and by the fishermen and prao-men along the coast and islands. At the height of the west monsoon in January and February, the several islands of the archipelago are practically isolated for weeks. The houses are built on piles. Drinking water is drawn from primitive wells which are so scarce that one well has to do for several houses and sometimes for a whole village. In the dry season most of the wells run practically dry. Near the sea in the coastal areas and on many islands the wells are so brackish that drinking water has to be fetched from elsewhere. The natives deposit their excrements on the land, but not in rivers, canals, or gutters.

The first cholera cases occurred in September 1937 in Pangkadjene and Barroe. Soon cases were reported in Sematelloe-Laoet, one of the islands of the Spermonde archipelago. Later, in January 1938, cases were reported from Gowa. In the same month, one case occurred in Macassar itself and new cases broke out in Barroe and in Maros. In February it appeared that the islands Salemo and Sanane of the Spermonde archipelago were infected. In April 1938 another case occurred in Macassar.

In 1937 and 1938, 48 cases were observed altogether. In October and November 1939 about 25 more; in June and July 1940, eight new cases were notified. The clinical picture was typical for cholera. Sixty-five per cent of the cases were fatal — as is usual for this disease.

Wells and water jars used by cholera patients in southern Celebes were examined and found to be infected, whereas wells belonging to the neighboring houses were not infected. Of 217 contacts of 40 cholera cases, 29 were found to excrete cholera bacilli. A few of these positive contacts showed later characteristic signs of cholera, but in no case did one of these positive contacts die. Of 183 probable contacts examined in 1937–38, not one was infected; but in 1940 some healthy non-contacts were found to be carriers. In one village where there had not even been a suspected case, 1.3 per cent of the population were found to be carriers. Of 17 carriers, 11 were under the age of sixteen. The findings of 1940 indicate that the spread of vibrios was not limited to contact persons or to wells and jars in the immediate environment of the patient.

Epidemiologically and bacteriologically this cholera epidemic in Celebes showed a few re-

markable points (14). There was hardly any tendency to an epidemic spread. In each of the fourteen villages only one case occurred; in each of four villages two cases; in only one village were five cases observed. With a few exceptions, there was never more than one case per family. These epidemiological data indicate differences from usual cholera epidemics.

In addition the vibrios isolated from the stools of the patients differed from the classical cholera bacilli. Bacteriological examinations showed the presence of bacilli with cultural and immunological characteristics of typical cholera vibrios. The immunological reactions showed these vibrios to belong to the genuine cholera organisms (sub-group 10 of GARDNER and VENKATRAMAN, Heiberg type 1). However, whereas genuine cholera vibrios do not produce hemolysis, the strains isolated in Celebes were definitely hemolytic.

The problem of hemolytic cholera vibrios is an old one and has been much discussed. Until the epidemic in Celebes occurred, everybody agreed that vibrios with all the cultural and immunological characteristics of cholera vibrios, but with hemolytic properties, were not pathogenic and had to be distinguished from genuine cholera vibrios.

The history of this problem goes back to GOTTSCHLICH, who in 1905, worked in the quarantine station of El Tor, where the pilgrims returning from the Hedjaz are examined. At the post-mortem of six different pilgrims who had died of diarrhea but not of cholera, GOTTSCHLICH isolated vibrios which could not be distinguished from cholera bacilli. Not only had these six patients not suffered from cholera, but in 1905 not one case of cholera had occurred in the Hedjaz. These so-called El Tor vibrios could later be distinguished from typical cholera vibrios because they were hemolytic. Since then the El Tor vibrio, a hemolytic cholera vibrio, has been considered a non-pathogenic type of bacillus.

Many investigators have, since 1905, studied this problem; and in 1930 DOORENBOS again isolated El Tor bacilli, but now from healthy carriers in the Hedjaz.

In the Netherlands East Indies, there had always been much interest in the possibility that El Tor vibrios might be found in this area also. Only in 1937, an extensive survey of the whole archipelago seemed successfully to prove that no El Tor vibrios could be isolated from 30,000 specimens of stools and surface water. Great, therefore, was the astonishment when in the Celebes epidemic hemolytic cholera vibrios were isolated.

The hemolytic properties of the Celebes strain could be clearly demonstrated by the technique of GREIG. These vibrios were frankly hemolytic when two- to three-day-old broth cultures were examined. However, the result of the hemolysin test of TAYLOR in pepton water cultures was less clear-cut. The Celebes strains were hemolytic when the pepton water cultures were one day old; but after cultivation for two days in pepton water — the method currently used in India — the strains were no more hemolytic. The Dutch bacteriologists, after carefully studying the Celebes strains, were of the opinion that the Celebes vibrios must be identified with El Tor vibrios, and that no reason existed to distinguish the disease of southern Celebes as "enteritis choleriformis Tor." From now on, hemolytic cholera vibrios or El Tor vibrios could no more be considered as non-pathogenic organisms.

These observations on the Celebes strains have revived the interest in hemolytic cholera vibrios in other areas. In British India, careful research for the presence of hemolytic cholera vibrios in cholera patients was resumed. It appeared that non-hemolytic classical cholera vibrios were found in all except one of the clinical cholera cases. The same vibrios were found in 7% of the close contacts of cholera cases and in 16% of the water sources which were in the direct neighborhood of cholera houses. Occasionally hemolytic agglutinable cholera vibrios which could not be distinguished from El Tor vibrios were encountered. They were rarely found in the presence of disease, but usually in persons who were not sick and who had not had any contact with cholera cases (15). Another survey demonstrated the presence of hemolytic cholera vibrios or El Tor vibrios in fifteen open natural water sources in two rural districts of India which were free from cholera (16). It should be added that in the same area, however, two non-hemolytic typical cholera strains were encountered. Therefore, until now, southwestern Celebes remains the only area where, during a typical cholera epidemic, hemolytic cholera strains, which could not be distinguished from El Tor vibrios, were isolated. In southwestern Celebes the El Tor vibrio is evidently pathogenic.

*e. Plague.* — The Netherlands East Indies had always been free from plague until 1905, when two cases were discovered in Deli on Sumatra's east coast. Both the watchman and the rat catcher of a godown, where rice from Rangoon was stored, died from plague. At the time no new cases were discovered, but since then it has been clearly realized by all the Public Health authorities of the Netherlands East Indies that the archipelago was in grave danger of being invaded by plague at any time. The hollow bamboo material which is generally used for the building of native houses and native furniture is an excellent breeding place for the ubiquitous rats. It was understood that, as the *Xenopsylla cheopis* occurred in large numbers on the rats of the Netherlands East Indies, the danger of an epidemic was imminent as soon as cases of plague were introduced from neighboring countries.

For six years, the medical authorities of the Netherlands East Indies lived in anxious suspense until, in 1911, the inevitable happened. Cases of plague appeared in East Java, first in the residency of Malang, soon also in Soerabaja, Kediri, and Madioen (17). In the year 1914, the number of cases reported in East Java rose to 15,751. Then, however, the number of cases of plague in this part of Java diminished progressively, and since 1928 the annual number of plague cases observed in the eastern part of Java has never exceeded 100.

In the meantime, however, the disease had spread westward. In 1916, the port of Semarang, on the north coast of Middle Java, was infected. This was the starting point for a serious epidemic in Middle Java, especially severe in the years 1921, 1924, 1925, 1926, and 1927. The peak year was 1925 when 30,000 cases were observed in Middle Java alone.

This outbreak in Middle Java can be considered the second phase of the epidemic.

In the meantime, the disease had spread to West Java, where in 1920, Batavia, and in 1922,

Cheribon, were found to be infected. Just as in East and Middle Java, the incidence of the disease in West Java was small in the first years after the epidemic started; but towards the end of 1932 and in the following years, more than 10,000 cases were yearly reported, and in 1933, even 20,569 cases. Since 1935, the incidence of plague in West Java has diminished considerably.

At the end of 1939, the total number of cases of plague observed since the beginning of the epidemic in 1911 was 215,104.

*Deaths from Plague in East, Middle and West Java 1911-1939.*

| | East Java | Middle Java | West Java |
|---|---|---|---|
| 1911 | 2,155 | 1 | 1 |
| 1912 | 2,276 | 1 | 1 |
| 1913 | 11,384 | 2 | 1 |
| 1914 | *15,751* Peak year | 5 | 1 |
| 1915 | 4,851 | 1,406 | 1 |
| 1916 | 595 | 592 | 1 |
| 1917 | 202 | 219 | 1 |
| 1918 | 221 | 513 | 1 |
| 1919 | 169 | 2,785 | 1 |
| 1920 | 248 | 8,891 | 13 |
| 1921 | 257 | 9,501 | 5 |
| 1922 | 137 | 10,891 | 1 |
| 1923 | 73 | 8,323 | 271 |
| 1924 | 157 | 12,547 | 349 |
| 1925 | 260 | *12,969* Peak year | 1,275 |
| 1926 | 71 | 6,829 | 871 |
| 1927 | 219 | 6,364 | 1,172 |
| 1928 | 35 | 3,741 | 824 |
| 1929 | 73 | 2,210 | 1,812 |
| 1930 | 3 | 2,282 | 1,695 |
| 1931 | 30 | 3,031 | 1,478 |
| 1932 | 5 | 2,051 | 4,366 |
| 1933 | 8 | 1,685 | 15,188 |
| 1934 | 2 | 2,668 | *20,569* Peak year |
| 1935 | 1 | 2,687 | 10,307 |
| 1936 | 4 | 1,693 | 4,490 |
| 1937 | 44 | 1,156 | 2,614 |
| 1938 | 20 | 616 | 1,447 |
| 1939 | 15 | 403 | 1,123 |

The incidence of plague in the ports and on the coasts of Java has always been negligible. Without exception, the main epidemic areas were in the hilly regions and the mountainous plateaus of about 1,000 feet (Malang, Magelang, Temanggoeng, Garoet, Bandoeng, Leles) and at the foot of isolated volcanoes.

This predilection of the disease for the interior of Java has made it possible to ascertain that the *Xenopsylla cheopis* alone is the vector of the plague and that the *Xenopsylla astia*, which is also a frequently occurring rat flea in the Netherlands East Indies, does not play a rôle as vector. The *X. astia* occurs mainly at the coasts and only rarely in the hilly interiors of the country. Because the disease prevails in the interior, the *X. astia* can hardly be held responsible for the spread of the disease.

The plague bacillus reservoir in Java is the Malayan house rat, *Rattus rattus diardi*, which builds its nests in the dark, especially in horizontal bamboos, on roofing poles and ceilings, in palm leaf thatched roofs, in the native bamboo bedsteads (the so-called balé-balé), in piles of timber, and stores of food. This rat species fortunately has no tendency to migrate; thus the epizootic of the rats is held in bounds. The importance of the structure of houses as breeding places for rats becomes apparent when one considers the prevalence of plague among the Indonesians in the very villages and cities where the Chinese and Europeans who live in houses built from other material remain practically free.

Fortunately, the plague epidemic has been practically limited to the island of Java. Outside Java, cases have been observed in

*a.* Palembang on Sumatra.

*b.* Tandjong Balei on Karimon Island in the Riouw archipelago off Sumatra where, in 1922, thirty-three cases occurred. The disease was possibly introduced from Malaya.

*c.* Macassar on Celebes where between 1922 and 1930, 150 cases of plague occurred. The peak of this small epidemic was in 1927 when 40 cases were observed. For comparison's sake, it should be added that, whereas in Java *Rattus norvegicus* and *Rattus concolor* have never been found to be infected with plague, in Macassar the latter two rat species were infected just as freely as the *Rattus rattus diardi*.

In 1914 the campaign against the plague epidemic was put into the hands of a special anti-plague service, belonging to the Public Health Service. This campaign has centered mainly around the application of two methods:

*a.* Extensive schemes for the improvement of houses and careful supervision of the building of new houses, where no occasion for the breeding of rats could exist.

*b.* Vaccination with a live plague bacillus vaccine as designed by OTTEN.

When houses were newly built or improved, the use of hollow bamboo which, as mentioned above, favors the breeding of rats, was permitted under no circumstances. The following principles were used for the improvement of the houses.

*a.* All thatched roofing was replaced by tiles or corrugated iron.

*b.* All unsplit, hollow bamboo was
   1. wherever possible, replaced by wood.
   2. where wood was scarce, wooden stoppers were inserted into the ends of the bamboo.

*c.* All parts that cannot easily be seen (that is pieces between two layers of open bamboo) were eliminated.

*d.* The square ridge pole was turned in at an angle so that no rat nests could be built upon it.

By the beginning of 1940, 1,579,753 houses had been improved and 962,400 houses had been built under the supervision of the anti-plague service. This campaign for the construction of improved houses has been one of the maiu factors in stopping the plague epidemic. On the other hand, this improvement of the houses has led to a new danger which shows once again how carefully one must weigh any interference with the customs and the ways of life of a native population (18, 19).

In the same area where, thanks to this improvement of housing conditions, the plague mortality decreased, the general mortality increased! This increase of the general mortality rate was due to a malaria epidemic which practically always follows within a few months after the houses have been improved. The improvement of the dwellings transformed the very undesirable huts of the Indonesians into neat little houses with tiled roofs. The kitchen, which in the original huts was combined with the living room, was in the improved house located outside the dwelling. A smoke-catching device provided excellent ventilation, and there was not the slightest doubt that the new houses had much more light and more air than the old native dwelling. Unfortunately, the absence of smoke

in the house permits mosquitoes to enter the dwelling. Mosquitoes, in general, abhor smoke. At the same time, smoke hides the odor of the human body; and when no smoke is present, the human body odor attracts the anophelines. Careful counts have shown that ten times as many mosquitoes were found in the improved houses than in the old unhygienic Indonesian huts. Most of these extra mosquitoes were proved to be the dangerous *Anopheles aconitus*, a situation which explains the spread of malaria, following the improvement of dwellings.

This unexpected and highly undesirable complication of the house improvement campaign is another example of man-made malaria. It shows that even in plague districts no campaign for the improvement of houses should be started without simultaneous and careful species sanitation.

The second measure which has been widely and successfully used in the anti-plague campaign has been vaccination with a living plague vaccine, as devised by OTTEN (20). His investigation first proved that there exists a relation between the susceptibility to plague of the experimental animal and the degree of immunity caused by a dead plague vaccine. He found it impossible to obtain a satisfactory immunity against plague in wild house rats and guinea pigs by means of a vaccine of killed plague bacilli, whereas in white rats and monkeys the same vaccine seemed to have a protective action. Tame white rats and monkeys are only slightly susceptible to plague infection, and the small degree of protection caused by the killed plague vaccine is sufficient for these animals. However, in highly susceptible animals, as in guinea pigs and wild house rats, killed plague vaccine is inactive. OTTEN saw at the same time that after repeated cultures in artificial media some strains of the plague bacilli became avirulent. One of these strains, which had become avirulent by such spontaneous attenuation, he used as a vaccine. First he proved to his satisfaction that susceptible experimental animals (guinea pigs and white rats) could be protected by injection with these living avirulent plague bacilli.

| | *Immunized dead plague vaccine* | *Immunized living plague vaccine* | *Same experiment repeated* | *Controls* |
|---|---|---|---|---|
| | Survival rate | Survival rate | Survival rate | Survival rate |
| Wild house rat [1] (*R. r. diardi*) | 20.1% | 82% | 81.2% | 0.9% |
| Guinea pig [1] | 11.1% | 91.2% | 90.5% | 0. % |
| White rat [2] | 83.5% | — | — | 5.4% |
| White mouse [1] | 63.1% | — | — | 0. % |
| Monkey [3] | 84.2% | — | — | 20.0% |

[1] Infecting dose 50,000 live plague bacilli
[2] — — 500,000 — — —
[3] — — 5,000,000 — — —

Then by experiments on volunteers he ascertained that this live plague vaccine did not cause any complications. Finally, he started vaccinating the population. He found that injection of this live plague vaccine reduces the plague fatality to about 25%. Unfortunately, this vaccine protects only against bubonic plague and not against pneumonic plague. The immunity does not last any more than six or seven months, and for the campaign against endemic plague repeated vaccinations are necessary.

By the end of 1939, about two and a half million people had received more than ten million vaccinations and revaccinations with this live vaccine without untoward results. This method, therefore, can no longer be considered a hazardous venture. For completeness' sake, it may be added that in Madagascar in later years a live plague vaccine has been used without any accident on 800,000 persons (21). A small-scale experiment in South Africa also gave a favorable result.

In recent years, the incidence of plague has considerably decreased. In 1938, about 2,000 cases; in 1939, about 1,500 cases were observed in Java. 1940 and 1941 were especially favorable years with 397 and 287 cases. It was generally accepted that this improvement was due to the modernization of the houses and the widespread vaccination with a live plague vaccine. It has been reported that, these measures having been neglected since the Japanese invasion, the plague epidemic has again spread considerably.

*f. Mite fever.* — In Sumatra many cases of fever of unknown etiology occurred. After careful study of this group, first a syndrome, which was originally designated as pseudotyphus, was separated. It soon became clear that this pseudotyphus consisted of at least two diseases: shop typhus or murine endemic typhus, and scrub typhus or mite fever, nowadays usually identified with tsutsugamushi fever. Both diseases are caused by special forms of rickettsiae. In northeastern Sumatra where most cases of mite fever have occurred, a special mite, the *Trombicula deliensis* (22), was found to be responsible for the transfer of the disease. More recently, a few cases described as mite fever have also been reported from Java, from the northwestern part of Dutch Borneo, and from Celebes, especially the northern arm of Celebes, the so-called Minahassa.

*g. Leptospirosis.* — Even after these two rickettsioses had been recognized and diagnosed, there still remained a group of febrile diseases the etiology of which was unknown. VERVOORT in 1920, cultivated from the blood of patients having one of these diseases a spirochete which he called *Spirochaeta pyrogenes*. Careful investigation into this group of spirochetal fevers ultimately proved that VERVOORT'S spirochete was closely related to the leptospirae which cause Weil's disease. It thus became evident that in Deli on the east coast of Sumatra, there was incident a febrile leptospirosis which, although jaundice occurred in only ten per cent of the cases and the disease was hardly ever fatal, still was closely connected with Weil's disease.

Gradually it transpired that the same disease occurred in still other parts of Sumatra; later it was found on Java, Borneo, Tarakan Island, and Celebes (23).

Not only did the East Indian leptospiroses differ from the clinical picture as known in the western part of the world, but the leptospirae were different from *L. icterohemorrhagiae*, the common spirochete of the European Weil's disease. Only rare cases of this western form of Weil's disease have been recognized in a few limited areas of the Netherlands Indies. A few such cases have been diagnosed in Semarang on the north coast of Java and also on the small island of Noesa Kambangan off the south coast of Java, opposite Tjilatjap. On this island many different leptospiroses occur because here

several thousand chain gang laborers, collected from all parts of the archipelago, work.

In northern Sumatra, however, where the disease is most frequent, some of the spirochetes isolated were identical with the *L. pyrogenes* of VERVOORT, nowadays usually called *L. selinem;* some were identical with *L. akiyama* or *L. autumnalis* of the Japanese.

In Java, Celebes, Borneo, Bangka, and Billiton, most of the cases were caused by another spirochete, the *L. bataviae*, which is highly pathogenic for guinea pigs. In Java the Norwegian rats, fifty per cent of which harbor the *L. bataviae*, form the leptospira reservoir. To make things still more complicated, the field rat of Java, the *R. r. brevicaudatus*, carries another spirochete, the *L. javanica* which is pathogenic for neither man nor guinea pigs (24).

Although the complete clinical picture of leptospirosis does not occur too frequently in Java, the disease cannot be rare, because seven per cent of all sera of patients with any febrile disease in Batavia agglutinate *L. bataviae.*

*h. Filariasis.* — Filariasis is a syndrome which results from the presence of a special round worm, nowadays called *Wuchereria*, in the retroperitoneal lymph vessels and lymph glands of the lower abdomen and the inguinal region. The signs of the disease — lymph scrotum, chylocele, lymphadenitis, lymphangitis — are mainly connected with obstructions of the lymph vessels and lymph glands. Often obstruction of the lymph vessels of the legs leads to elephantiasis. Sometimes chyluria and often fever occur. In the peripheral blood, the microfilariae can usually be found. For many decades, this disease was known to occur very frequently in the Indo-Australian archipelago; but until 1927, only one kind of *Wuchereria*, the *W. bancrofti*, had been identified. The common house mosquito, *Culex quinquefasciatus* or *C. fatigans*, had been recognized as the main vector of this disease.

The history of how a new *Wuchereria* was discovered in the Netherlands East Indies offers a few interesting points. When a *Culex fatigans* sucks blood from a filaria patient, microfilariae enter the intestinal tract of the mosquito. They penetrate the stomach wall and reach the thoracic muscles of the mosquito, where they lose their sheath. Gradually these sheathless microfilariae develop into adult worms, which are found, after about ten days, in the head of the mosquito. When a normal individual is bitten by such an infected mosquito, the adult worm is introduced into the human body, ultimately reaching the retroperitoneal fibrous tissue from where the infection with microfilariae starts.

A Dutch Army physician, stationed in a tiny garrison in northern Achin in northern Sumatra, found that at least one-third of his community was infected with filariae. This physician, however, was struck by the fact that only elephantiasis occurred, and that other signs of the lymphatic system were absent. He never saw a case of chyluria, chylocele, lymph scrotum, or lymphangitis, and his colleagues of the surrounding garrisons informed him that in their areas also only elephantiasis and no other manifestation of filariasis were encountered.

At the same time, this Army physician tried to infect *Culex fatigans* with the filariae of his patients. The description of the experiments performed by this physician, isolated in a little native village of Sumatra, gives a vivid impression of his scientific interest. He caught considerable numbers of *Culex fatigans* and let them feed on a heavily infected Indonesian. The specimens which had sucked blood were isolated from the rest and kept alive in a jampot with some sugar water. They were dissected at different intervals after the blood meal.

Instead of observing in the infected *Culex fatigans* a development of the microfilariae into adult worms, as he had been taught to expect, he saw that the filariae did not develop, but died two to three days after they had penetrated the muscles of the thorax. He then recognized the importance of his results which did not agree with current knowledge; that is, the absence of genital lesions in his filaria patients and the impossibility of infecting *Culex fatigans* with the filariae of northern Sumatra.

He was so much impressed by these two facts that he considered the possibility of an unknown *Wuchereria* as the cause of filiariasis in northern Sumatra. He made careful blood smears of his filaria patients, stained them and sent them to Batavia in order to have them studied by a competent parasitologist.

This examination was made by Dr. BRUG, who found that, in contrast to the microfilaria of *W. bancrofti*, the microfilariae from northern Sumatra presented a few nuclei in the tail, that the anal porus of the filaria from Sumatra was placed more forward than in *W. bancrofti*, and that a few other less important but constant anatomical deviations could also be distinguished. Thus he was led to the discovery of a new filaria, *Wuchereria malayi*, to which the name of BRUG has been added. Unfortunately, LICHTENSTEIN, the Army physician whose original work contributed so considerably to this discovery, is never mentioned in connection with it.

So it was determined that this *W. malayi* is not transferred by *Culex fatigans*, but by other mosquitoes belonging to the *Mansonia* and *Anopheles* species (25–29).

It has since transpired that much of the filariasis in the western part of the East Indian archipelago — and of China — is due to *W. malayi.* In Sumatra, both *W. bancrofti* and *W. malayi* are found. In Java, filariasis is rare and breaks out only in the delta of the Serajoe River on the south coast, where *W. malayi* alone is found. On the island of Celebes, practically all the filariasis is due to *W. malayi;* but on the islands off southeastern Celebes, the disease is again caused by *W. bancrofti*. On Ceram Island, off eastern Celebes, all filariasis cases are due to *W. malayi*. On near-by Boeroe Island, only *W. bancrofti* is found, as is also the case on all the islands east of Boeroe and on New Guinea.

*i. Miscellaneous.* — These examples tell only a part of the story of the scientific work of the physicians of the Netherlands Indies. A few other discoveries may also be mentioned shortly.

The causative organism of paratyphoid C, the *Salmonella hirschfeldii* which WEIL described in 1917 and NEUKIRCH in 1918, was discovered already in 1908 by VAN LOGHEM in Deli on Sumatra's east coast. VAN LOGHEM isolated this germ from a group of febrile patients and designated it at the time as *Bacillus suipestifer Deli.* This *Salmonella* is a frequent cause of epidemics in Sumatra and Java (30), whereas *Salmonella paratyphosus B* has been proved to be extremely rare in the archipelago. Three new *Salmonella* types have been discovered in this area (31).

The investigations of VAN STOCKUM on rabies vaccination have unfortunately not received the recognition they deserve (32). She proved to her satisfaction that all the different rabies vaccines are inactive, and devised a new and active vaccine consisting of the formolized central nervous system of experimentally infected monkeys. This preparation was in later years the only vaccine used in the Netherlands Indies.

Here the forgotten fact that the arsphenamine treatment of frambesia was discovered in 1911 by the Netherlander FLU must be recorded. It must be added, however, that at the time, FLU did not work in the Netherlands East Indies, but in the Netherlands West Indies in Suriname.

Of great importance for medical practice in the whole Orient was the preventive work of SCHÜFFNER and KUENEN in Deli (33). By careful study of the diseases among the native laborers and by devising preventive measures, they reduced the very high mortality on the estates to normal levels and thereby rendered the agricultural development of many unsalubrious regions possible.

**Summary.** — Occasionally disparaging remarks have been made about the Public Health System which the Dutch authorities had developed in the Netherlands Indies. The core of the argument is usually derived from a comparison between the surface of the archipelago (760,000 square miles), the number of the islands (about 3,000), the population (about 65,000,000), the distances (from east to west about 3,000 miles), and the relatively small number of physicians who had been working in this enormous area (33). Such superficial criticism, which is usually built upon "experiences" collected during a flying visit of a few weeks to a few cities of the Netherlands Indies, hardly deserves special attention.

Anyway, the facts talk a different language. Thanks to the Public Health Service of the Netherlands Indies, the general death rate of the population has decreased to twenty or twenty-five per thousand, which is favorable for an oriental population. The general sanitation is so well organized that the death rate of the Europeans in the larger cities does not exceed nine or ten per thousand.

These results have been obtained by overcoming serious difficulties. The Netherlands East Indies belong to the most malarious regions of the world, and the density of the population of some parts of the archipelago ranks with the highest figures known. The average density of the population of the island of Java is 800 per square mile and of Middle Java even 1600 per square mile. The highest figures for Europe are found in England with 1150 and in Belgium with 1060 per square mile. The over-population of Java is especially serious because Java is a purely agricultural territory, whereas England and Belgium are industrial and commercial countries. It should be added that, although the Netherlands Indies are surrounded by countries where smallpox, cholera, and plague epidemics occur practically every year, smallpox and cholera had been almost eradicated from the Netherlands Indies and the plague epidemic was well under control. These results can easily stand comparison with the health conditions in the imperium, colonies, protectorates of other countries where the number of physicians may or may not have been greater, compared with the number of the population.

Finally, as described above, the weight of the scientific contributions of this small corps of Dutch physicians who have been devoting their efforts to the Public Health Service of the Netherlands East Indies is considerable. The physicians of the Netherlands owe a debt of gratitude and appreciation to their colleagues who have transformed the notoriously unhealthy Netherlands Indies into a healthy territory.

It has been an honor to be allowed to collect the facts mentioned in this article as a token of appreciation for the work of the physicians and the biologists of the Netherlands Indies, a few of whom have been sighing under German oppression, and many of whom are still suffering the indignities and dangers of Japanese internment camps.

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# THE GEOLOGY OF THE NETHERLANDS INDIES

*by*

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## I. INTRODUCTION

The following compilation attempts to give a sketch of the geology of the Dutch East Indies, its development, general setting in global geology, structure, stratigraphy, and economic application. The writer spent over five years in various parts of the Dutch East Indies as geologist of the Bataafsche Petroleum Maatschappij and he wishes to thank the Directors of that company for granting permission to publish this article. Many Dutch geologists would have been more competent to describe the complex features of the geology of the Dutch East Indies but, at present, it appears that they are all interned by either Germany or Japan.

## II. DEVELOPMENT OF GEOLOGICAL KNOWLEDGE

The study of the geology of the Dutch East Indies is handicapped in most regions by dense forest, the heterogeneity of the geological features and by the physical difficulties of travelling. This is especially true in the mountainous regions of the larger islands with the exception of Java. Surface outcrops, as a rule, are restricted to river beds, both large and small, and the geologist must conduct his survey along or in the rivers, which is usually a rather wet job. As a consequence, knowledge of the geology of these islands is less complete, in general, than in the best studied areas of Europe or the U. S. A. — a fact well illustrated on regional maps by patches of "al fresco" geology as well as by blank spots. To the present time it has been roughly estimated that about a thousand geologists have set foot on the Dutch East Indies during the past hundred years and that between four and five thousand publications on the geology of the region have been printed.

The earliest geological observations on the Dutch East Indies were recorded in the 17th century by G. E. RUMPHIUS. Considering the period in which it was done, the work of RUMPHIUS is truly remarkable. The 18th century failed to arouse any scientific interest in the colony but, in contrast, during the first half of the 19th century the study of geology attracted many scientists. It must be admitted, however, that this stimulated interest in geology trailed far behind the interest shown in botany and zoology. The observations were of a local nature and no large-scale mapping nor discussion of general problems was attempted. An exception to this is the outstanding monograph and geological map of Java by F. JUNGHUHN which inaugurates the beginning of serious geological research in the Dutch East Indies.

This period of more serious work was well launched with the publication of the first volume of the "Jaarboek van het Mijnwezen in Nederlandsch Indië" (Annual of the Mining Department of the Dutch East Indies) in 1872, with the appearance of the "Tijdschrift van het Koninklijke Nederlandsch Aardrijkskundig Genootschap" (Journal of the Royal Dutch Geographical Society) in 1876, and with the beginning of the teaching of geology in the three Dutch universities — Leiden, Utrecht and Groningen — in 1878. Direct results of this stimulus were: *1*) greatly increased interest in the homeland toward the study of geology in the colony, *2*) numerous regional explorations performed by the geologists and engineers of Mijnwezen and, *3*) the accumulation and study of collections of fossil and rock specimens in the universities of Holland.

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* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

The period of most rapid progress of geological work in the Dutch East Indies began after 1900. Mijnwezen had been concentrating its activities to problems of practical geology such as the discovery and exploration of valuable mineral deposits. The purely scientific exploration and geological mapping of the various islands became temporarily of secondary importance. After 1920, however, Mijnwezen began a detailed geological survey of Java and parts of Sumatra and has published a number of regional geological maps covering the entire Archipelago.

Between the years 1888 and 1914 privately financed scientific expeditions, mostly Dutch with a few Swiss and German, explored many of the islands and have contributed a great deal to our knowledge of the geology of the Dutch East Indies.

Another factor which greatly stimulated geological research has been the employment of scores of geologists by the various oil companies operating in that region. Up to the present time these geologists have mapped in considerable detail practically all the Tertiary basins in the Dutch East Indies. Especially during the decade immediately preceding the catastrophe of 1942, the oil industry employed many field geologists for surface mapping; paleontologists for fossil determination in connection with proving the age of the strata encountered; geophysicists to direct seismic, gravity and other geophysical exploration on the vast alluvial plains lacking natural outcrops; aeroplane-survey companies with their staffs for aerial photography of unmapped jungle areas and subsequent detailed photo-geological interpretation of the pictures; and, finally, shallow drilling campaigns to locate faults or anticlines by means of fossil or electric-log correlations. Although it is true that most of the reports of these excellent studies are buried in the files of oil companies, a number of them have been released for publication in recent years. The geologists and mining engineers employed by the gold, silver, tin and coal mining industries, as well as other private mining interests, have likewise contributed their share to the geological knowledge of the Dutch East Indies.

Mention should be made of the establishment by the government of an agro-geological institute and the employment of a few geologists by planter associations. Also, a special government organization has been set up for the study and continuous observation of the many volcanos of the Archipelago. This latter work has largely been done very efficiently from aeroplanes.

This joint effort by the government and by the oil and mining companies, coupled with private scientific research, has made it possible to cover geologically about 80% of the area of the Dutch East Indies. Much of this work has been done in remarkable detail. The 20% of the area which still remains "terra incognita" is confined to portions of central Borneo, eastern New Guinea, mountainous regions in many parts of Celebes and the interiors of several islands in the Moluccas.

## III. GENERAL SETTING IN GLOBAL GEOLOGY

Practically all islands of the Dutch East Indies are situated in the zone called the Alpine-Himalayan geosyncline which occupies roughly the area of the ancient Tethys Sea. This great geological feature merges here into the Circum-pacific geosyncline, one branch of which strikes across the Philippines toward Japan and the other branch via New Guinea toward New Zealand. It is a belt of labile equilibrium and relative weakness in the earth's crust. This comparatively narrow Alpine-Himalayan geosyncline is bounded on the north by the highly rigid mass of the huge Eurasian shield (northern Europe and Asia) and on the south by the Gondwana block (now split into Brazilian, African, Indian and Australian shields).

From Cretaceous time to the present, horizontal movements of considerable but unequal magnitude, especially in the Gondwana block, affected large portions of the solid crust and exerted tremendous pressure on the geosyncline. The compression resulted in the formation of high mountain chains accompanied by extensive folding, overthrusting and the appearance of numerous volcanos. This orogenic process has already passed its climax in the Alps and in the Himalayas, as evidenced by their size and altitude as well as by the extensive and complicated system of overthrusting and the relative scarcity of active volcanos. In contrast, the region of the Dutch East Indies represents, most probably, a youthful stage of the orogenic process. Its mountains, as a rule, are restricted in extent and of low altitude with fewer and smaller overthrusts but very rich in active volcanoes.

The island festoons off the west coast of Sumatra, the lesser Sunda Islands and some of the island strings in the Moluccas may be regarded as representing the embryonic stage in the life cycle of a mountain system. In so far as one can visualize, the Alps were in a comparable condition during late Cretaceous or early Tertiary time.

It may be said, therefore, that the Dutch East Indies represents one of the most promising areas for research on certain phases of major deformations of the earth's crust. It is to be hoped that, in the future, concentrated effort in geology, geophysics and volcanology will again be directed here in order to try to solve a few more mysteries of nature.

## IV. STRUCTURE

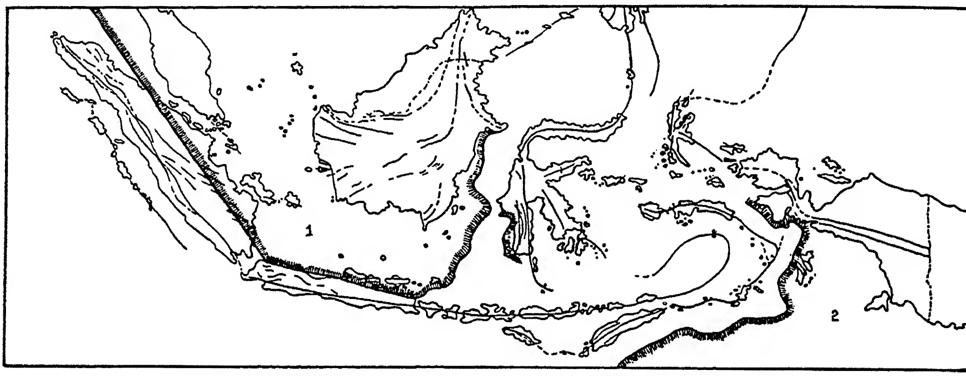
*General.* — In the Dutch East Indies the southernmost portion of the Eurasian shield, adjoining Malacca Peninsula and the shallow China Sea, occupies the east coast of Sumatra, a narrow strip along the north coast of Java, the shallow Sunda shelf (including Banka, Billiton, Riouw archipelago, etc.) and the greater portion of Borneo. The Australian shield extends over only a minor portion of the Dutch East Indies, *viz.*, the very shallow and flat Sahul shelf, the group of the Aru Islands and most of the flats of South New Guinea. All of these regions are exclusively occupied either by shallow seas, by vast alluvial plains covering peneplaned terrains of mostly igneous or metamorphic bed rock, or by moderately elevated hills and plateaus with mature topographic features.

Pressed in between the two shields are a number of long and narrow mountain systems which are generally separated from each other by deep sea channels. Connecting with Burma the largest orogen extends throughout Sumatra, across Java and the lesser Sunda Islands to Banda whence it seems to fade out toward the southwest (or, possibly joins with Celebes). Another line connects the islands of Sumba, Timor,

Tenimber, Kei, Ceram and Buru and lies parallel with the Sunda-Banda archipelago. Celebes forms another complex system which, in the north, joins with the Philippines. The New Guinea mountain system, the highest of all and nearest to the Alps in structural type, finds its continuation in Halmaheira. The great similarity in topographic form of Celebes and Halmaheira is very striking. These two islands are situated at the hinge of the Alpine and the Circumpacific moving belts and it seems reasonable to suppose that identical structural forces may be responsible for creating those twins of unequal size. Mountain forming forces are still very active in the eastern Archipelago at the present time as proven, for example, by the elevated Quaternary coral reefs found on Timor at altitudes up to 1400 meters.

called trunk folds and lie in between broad, flat synclines. The greatest number of anticlines occurs in the area of maximum width of the island in the vicinity of Palembang. Another concentration of folds is to be seen in the northern part of Sumatra both to the north and to the south of Medan. The central part of the island, Indragiri, shows few structures on the map and South Sumatra even fewer. In the latter area this may be partly due to the impracticability of measuring the dip and strike in the unconsolidated, young volcanic deposits of the Lampung district.

The main structural movements in Sumatra, as is generally the case throughout the Dutch East Indies, occurred in late Tertiary time. Along the crest of the range of the Barisan Mountains, and frequently forming its highest




THE MAIN TECTONIC FEATURES OF THE DUTCH EAST INDIES

*Main structural line*

*Boundaries of* *1. Sunda Shelf (Eurasia)*
*2. Sahul Shelf (Australian Shield)*

— FIGURE 80 (*after* BROUWER) —

*Sumatra.* — The main structural features of Sumatra are parallel with the length of the island. This applies to the pre-Tertiary as well as to the Tertiary folding. The backbone of Sumatra is represented by the Barisan Mountains which lie close to the west coast and contain some centrally located longitudinal depressions (fault zones?). Most foothill structures east of the mountains seem to fan out slightly toward the east and gradually disappear near the edge of the Malacca shield.

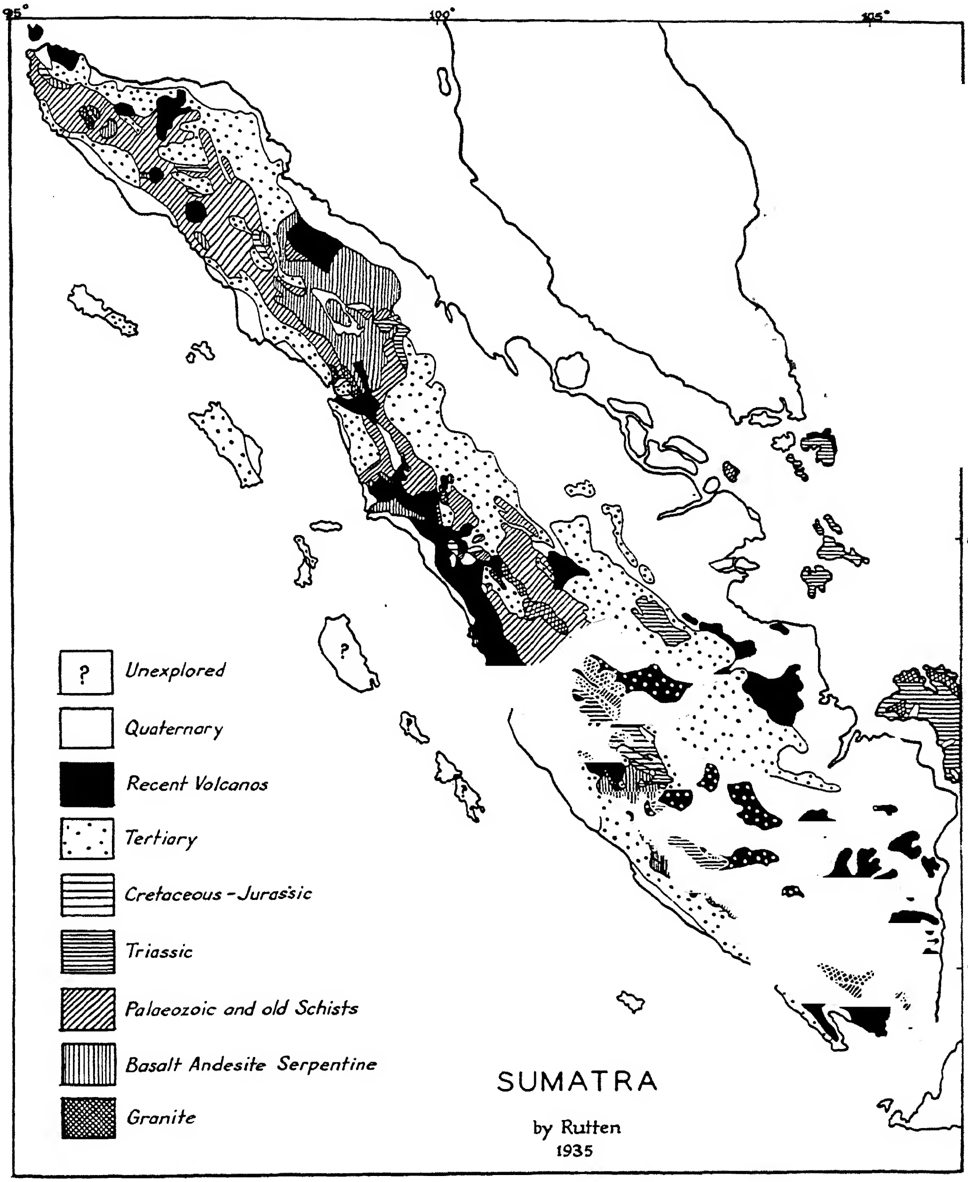
The detailed structure of Paleozoic and Mesozoic rocks is generally obscure because of restricted areas of outcrops. However, in the West Djambi district of South Sumatra it has been observed that large overthrust folds occur in the Permo-Carboniferous strata. West of the Barisan Mountains only a few Tertiary anticlines have been formed along the narrow coastal plain. East Sumatra, on the other hand, reveals a very large number of long, narrow anticlines and synclines, formed "en échelon" with culminations and saddles, longitudinal crestfaults and innumerable small cross-faults. The common type of Tertiary anticline here has a flat crest with very steep, short flanks. They are

peaks, are a large number of both active and extinct volcanoes. The most famous of these is Krakatau lying in Sunda Strait between Sumatra and Java, whose spectacular eruption in 1883 is well known the world over.

*Java.* — The major structural lines appear to lie in an east-west direction in Java — roughly through the central part of the island. The type of pre-Tertiary structure, however, is not known as the area is blanketed by the deposits of numerous active volcanoes. Volcanic deposits cover about one-third of the surface of the island. The mountains of Java do not consist of chains or continuous masses but are composed of strings of large and high volcanic cones separated by broad valleys and flats. Most of the Javanese volcanoes are arranged in E–W lines but some of them, such as the Tengger-Semeru south of Surabaya, appear in N–S lines, indicating cross disturbances at depth. In the northern plains a large number of Tertiary anticlines have been observed, most of which are topographically expressed as long, narrow ridges. The greatest number occur in the region between Semarang and Surabaya and extend eastward into the island of Madura. Some of these anti-

clines exhibit very steep flanks but, on the whole, the intensity of folding appears to become reduced toward central and western Java. The Tertiary formations found along the south coast of the island are, as a rule, horizontal or only slightly tilted.

Dutch East Indies. The limited areas of Tertiary sediments reveal evidence of only slight influence due to folding and faulting. Also, it is worth mentioning, that the volcano Tamboora on the island of Sumbawa, during its eruption in 1815, ejected not less than 150 cubic




- FIGURE 81 (*after* RUTTEN) —

*Lesser Sunda Islands from Bali to Banda.* — The lesser Sunda islands are of the same type as Java although here the individual volcano groups, as a rule, are separated by the sea instead of by plains, as on Java. As practically all of these islands are built up of young, unconsolidated volcanic material, very little is known of the underlying structures in this part of the

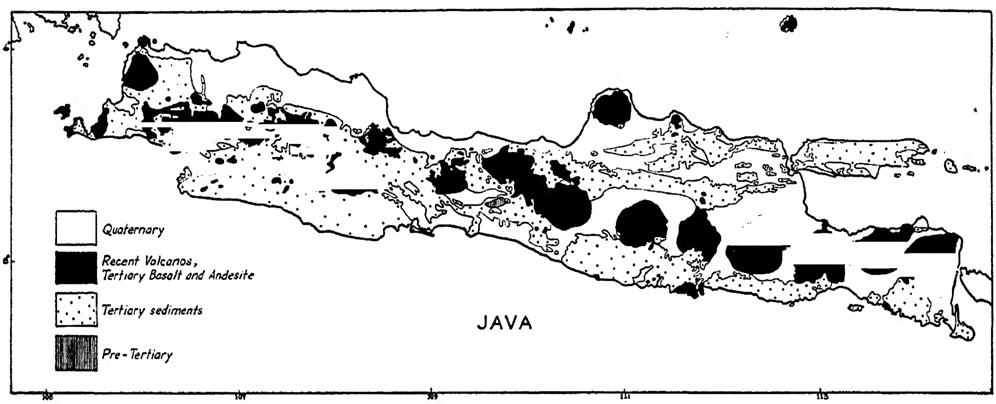
kilometers of material in a short time. Banda, the last island of this group, is nothing but a volcano emerging from the sea.

*Sumba-Timor-Tenimber-Kei-Ceram-Buru archipelago.* — In contrast to the above mentioned island string, the Timor-Ceram belt has no active volcanoes whatever and the sedimentary formations present, including Paleozoic, Meso-

zoic and Tertiary, as a rule are well exposed. The general trend of structures in all formations extends, for the most part, in the direction parallel with the archipelago. The main exceptions to this rule are the branching off of the easternmost island group of Kei in the direction of New Guinea and also certain irregularities on Ceram and Buru. Our present knowledge is too fragmentary to attempt an analysis of the various orogenic movements, with their intensities and direction, taking place at different times. In detail, the observed structures on most of the islands are extremely complex. For example, in many regions on Timor, only the introduction of sizable overthrusts can explain the position of older sediments resting upon younger ones over considerable distances. The same is true for other islands, *e.g.* Ceram, where the Triassic lies on top of the Cretaceous-Jurassic sequence. The general direction of overthrusting appears to be from the Banda Sea outward.

pushed in the direction of the Australian shield.

In the neck of the Vogelkop, between Geelvink Bay and Macluer Gulf, the orogen is reduced to a few narrow anticlines. However, farther north and along the north coast of the Vogelkop the orogen grows rapidly in width and elevation, forming another complex mountain system again with indications of overthrusts toward the south. South and west of the little town of Manokuari are two Tertiary volcanoes which, at times, have been reported smoking. Except for these two highly doubtful "active volcanoes" none exist within the boundaries of Dutch New Guinea. To the north of the Snow Mountains is situated a broad longitudinal depression called the Meervlakte. This depression is bounded on the north by a very complicated belt composed of numerous, highly compressed anticlines (occasionally with igneous and metamorphic cores) and also, some smaller igneous masses of unknown structure.




— FIGURE 82 (*after* RUTTEN) —

A possible exception to this general direction of overthrusting may be found on Buru. Sumba and Kei are two island groups in this belt which appear least affected by folding processes as the Tertiary formations present there are observed to be either horizontal or to form only gentle undulations. The vertical movement in recent times in this archipelago is considerable, as shown by the elevated Quaternary coral reefs on many of the islands.

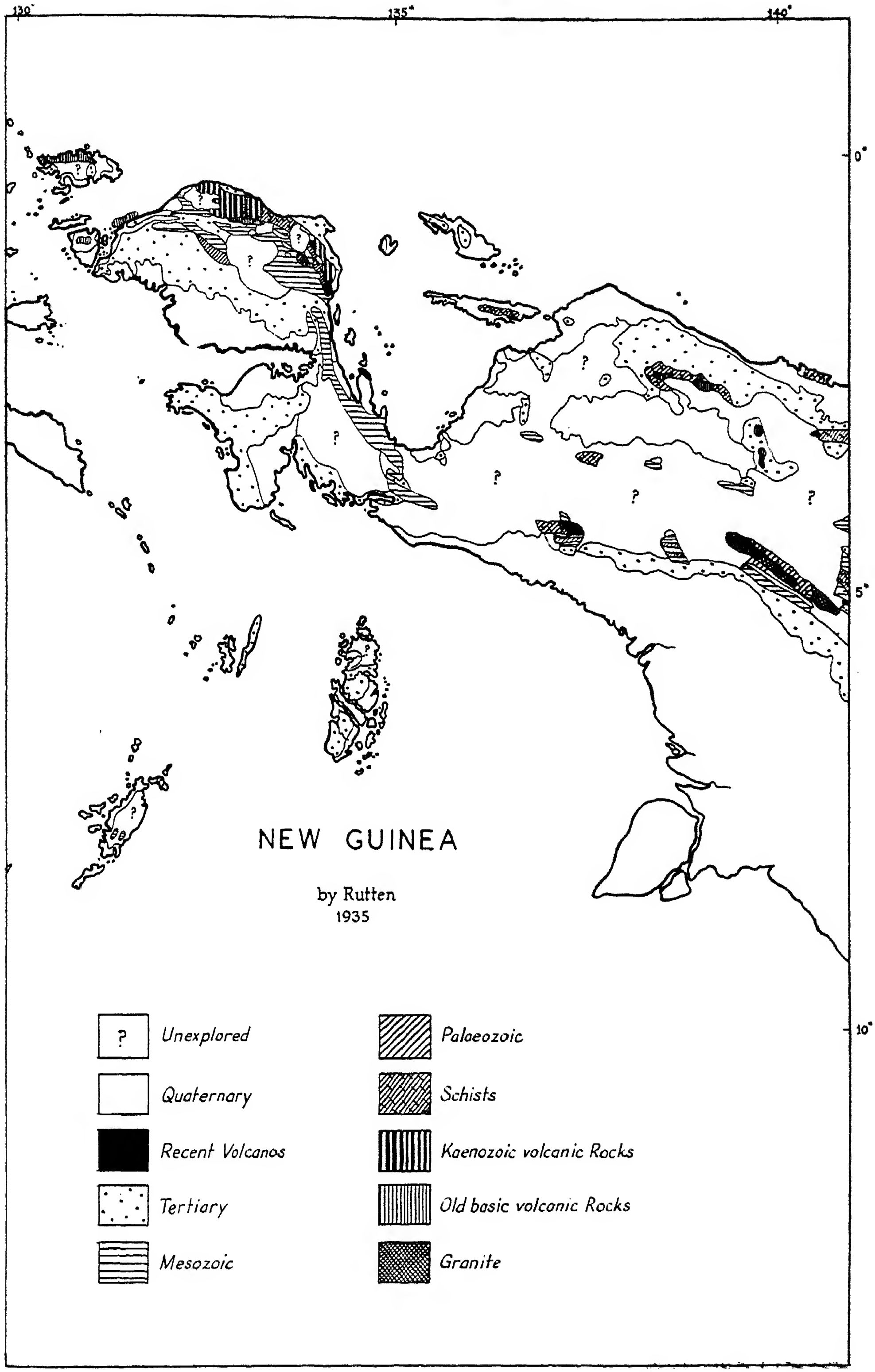
*New Guinea.* — The structural picture of New Guinea is strongly dominated by the central mountain system, the Snow Mountains, which trend east-west except in the area of the Vogelkop where the trend is north-south. Within the Vogelkop the east-west trend is regained near Manokuari. The Snow Mountains, extending 800 kilometers in length and from 150 to 200 kilometers in width, with hundreds of peaks more than 3000–4000 meters in elevation and with several glaciers and permanent snow fields directly under the equator, may be considered a typical Alpine-Himalayan orogen. The structure of the Snow Mountains has not been explored to any extent, as yet, but the observations made in the Carstensz massif and the predominant northerly dips leave little doubt that here we are in the presence of a complex overthrust system,

The island of Japen is a sharp, possibly faulted, anticline in metamorphics and Miocene limestone. The Schouten Islands show, in the north, flat structures in the Miocene and in the south, elevated and tilted Quaternary coral reefs.

The foothills of the southern part of the Vogelkop are composed of a number of long, narrow Tertiary folds. The Peninsula of Bomberai contains a few broadly arched flat anticlines exposed in Miocene limestone. The vast plain lying to the south of the Snow Mountains seems to contain no Tertiary foothill structure of any considerable size. If present, such structures may lie buried beneath the great thicknesses of Quaternary gravel terraces which follow the foot of the Snow Mountains as a wide belt.

*Halmaheira.* — This strangely shaped island is in direct connection with western New Guinea through the islands of Waigeo, Salawati and Gede. The tectonics of Halmaheira are still very obscure, as no geological map has ever been made of this island and only scattered, local information is available. We are, however, safe in assuming that the long, narrow arms of the island represent definite structures of some sort. This is substantiated by the beautiful row of active volcanoes, including Ternate, along the west coast.

*Celebes.* — The island of Celebes is not only




— FIGURE 83 (*after* RUTTEN) —


FIGURE 84 (*after* RUTTEN). — For legend see Fig. [illegible]

complicated as regards topography but still more so geologically. Its structure represents a strange combination of almost recent rising of the land of widespread volcanic activity; unequal folding in different areas at different times; and considerable faulting along the coastal regions and in the interior. The regional strike of the formations frequently does not follow the topographic outline of the island; for example, the formations in northwest Celebes seem to cut across the island, thereby suggesting a former connection with the Sankulirang Peninsula in Borneo. As evidenced by youthful coral terraces elevated to heights of 500 to 1000 meters above the present sea level, many parts of Celebes must have risen very considerably since late Pleistocene or even more recent time. Cretaceous and Tertiary sediments were folded, often very sharply, in late Tertiary time, as can be observed in South Celebes, Buton and Muna. Contemporaneous with these folding movements, or partly somewhat later, many faults developed along the edge of the island with occasional graben in the interior. Active volcanism, which, in early Tertiary time, spread over the greater part of Celebes, is at present restricted to the extreme northeast portion of the island around the town of Menado and the adjoining island string pointing north. As already mentioned, the complicated tectonic features of Celebes may be due to its location in the "whirlpool" at the juncture of Alpine and Circumpacific geosynclines.

*Borneo.* — This large island consists of a western and central upland of moderate altitude, a wide southern plain and an eastern hill belt parallel to the coast line. East Borneo is generally a flat plain of variable width between sea and foothills, with large flats in the interior, such as the lake basin of the middle Mahakam River. In central and western Borneo at least six clearly distinguishable orogenic phases have been observed. These took place in the following order: *1*) in pre-Permo-Carboniferous time, *2*) between Permo-Carboniferous and Triassic, *3*) between Upper Triassic and Cretaceous, *4*) during Cretaceous time, *5*) during Lower Tertiary and *6*) during Upper Tertiary time. From this it can be readily seen that the structure here is highly complicated. It must be said, however, that the latest Tertiary orogeny did not produce as profound changes as may be seen in central and western Borneo where only a slight tilting of the formations resulted from it.

Two major directions of regional strike have been ascertained — one NNE–SSW and the other approximately E–W. Besides, in western and central Borneo, a NE–SW direction dominates the above mentioned orogenic phases of Cretaceous age and older. The Tertiary structures, as a rule, are organized in an E–W direction. Along the east coast the prevailing strike of the anticlines is NNE–SSW as far as the peninsula of Sankulirang where the direction abruptly changes to NW–SE. Evidence of cross folding and faulting has been observed in many places and this may account for the existence of the large interior basins.

A number of long, highly compressed anticlines are exposed along the east coast from Cape Selatan and Pulu Laut as far as Sankulirang. As a whole these structures pitch at a low angle towards the north. In South Borneo, Cretaceous rocks and igneous basement are exposed in the cores of the anticlines, but North of the Mahakam River, only Tertiary deposits are outcropping. In Sankulirang the strike changes locally to E–W and suggests a relationship with Celebes in this area. Farther north the strike changes abruptly once more and becomes NW–SE, cutting entirely across both Dutch and British Borneo to the north coast of Brunei. The east coast folding represents the late Tertiary orogenic phase and here very few traces are to be found of the older movements so clearly depicted in western Borneo. Apparently, western and central Borneo became practically rigid in early Tertiary but movements along the eastern shore may be in progress even at the present time. Earthquakes are relatively frequent in eastern Borneo while rare in western and central Borneo. Active volcanoes are lacking on Borneo. However, two tiny cones of probable Pleistocene age (one with a small crater lake) have been discovered in southern Kutei near the Mahakam River.

*Unconformities.* — The Dutch East Indies have undergone several cycles of uplift, folding with emergence and subsequent erosion. This is clearly evidenced by the six orogenic stages observed in western Borneo. These orogenic movements are disclosed by the presence of unconformities showing transgression of marine sediments over peneplaned land masses. Owing to the fact that the region of the Dutch East Indies is, and has been far back into geological time, an assemblage of changing islands, unconformities are mostly of a local nature. The marine transgression over the various levelled islands occurred at different times, whereas the seas between the islands received continuous deposition. Possibly, during alternate orogenic stages, this marine intra-island region was folded up to become dry while the former island remained beneath the sea. Perhaps for this reason no unconformity can be traced throughout the Archipelago.

In addition to the unconformities observed in western Borneo a few more may be mentioned here. In Timor, between Middle Tertiary and Late Pliocene-Early Pleistocene; in Sumatra, between Late Mesozoic and Early Tertiary; in Java, between the Triassic and Middle Cretaceous (Cenomanian); in eastern Borneo (locally), between Cretaceous and Eocene.

## V. STRATIGRAPHY

*Paleogeography.* — After Permian time the Gondwana block and Eurasia were separated from each other by the Tethys Sea. The fossils clearly indicate that, between Permian and early Tertiary times, a close connection existed between the present Dutch East Indies and the Mediterranean region. Often the fossil faunas are found to be practically identical and sometimes they exhibit variations and specific differences clearly dating the formation of temporary land bridges or other barriers to the interchange of faunas within the Tethys Sea. In Eocene time the water connection between the Mediterranean region and the Indies was definitely severed by uplift, thereby cutting the Tethys area into a number of marine basins separated from each other by broad land bridges. Several restricted depositional basins were thus created in the region of the Dutch East Indies during Eocene time, gradually becoming filled with eroded material from adjoining land masses

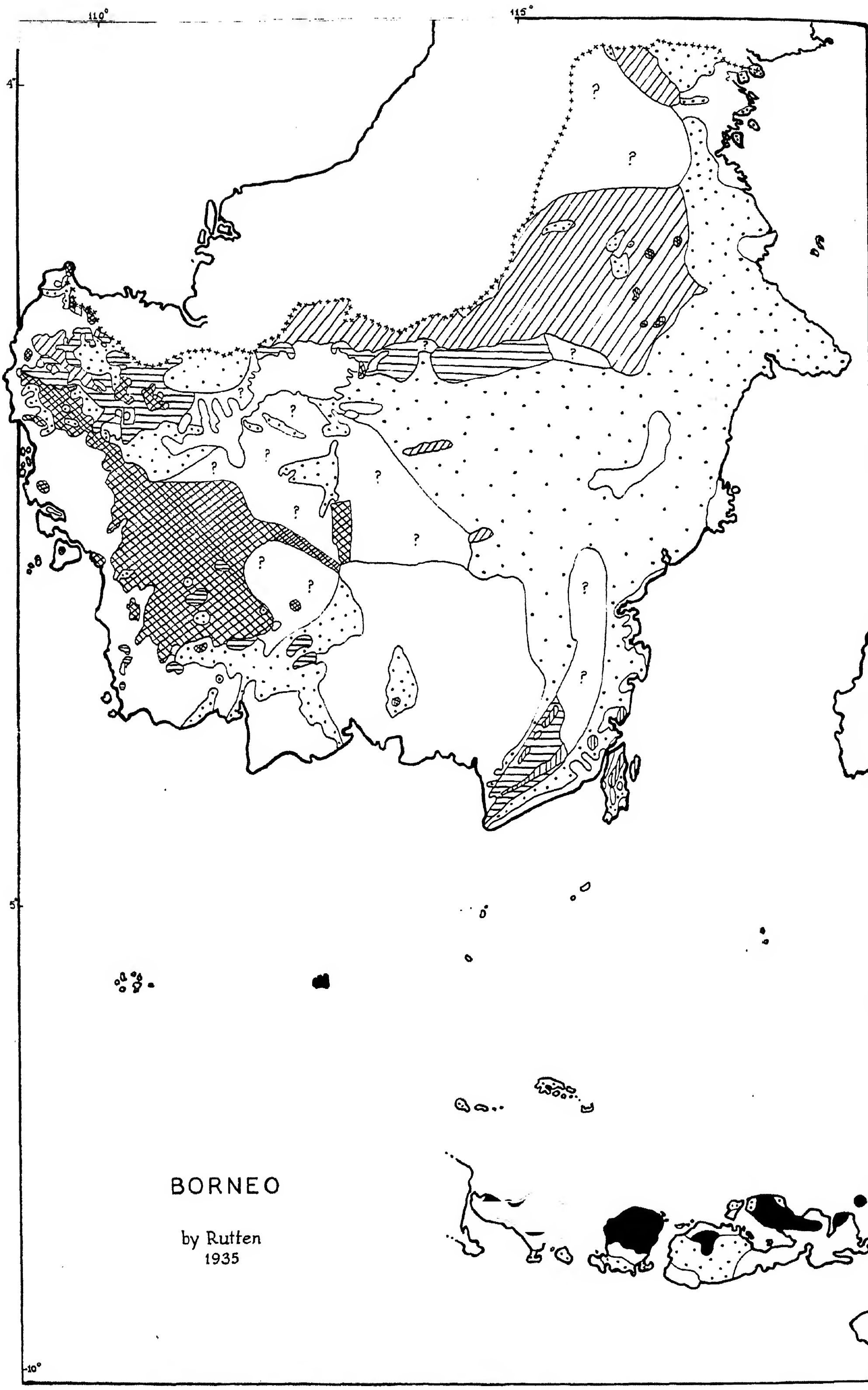



FIGURE 85 (*after* RUTTEN). — For legend see Figure 81.

with eroded material from adjoining land masses throughout the period of the entire Tertiary. A number of these Tertiary basins are now quite dry but the elevation of their present land surface is still very close to sea level. The following brief descriptions give a general summary of the formations present in the Dutch East Indies.

Formations as old as *early Paleozoic* are very scarce in the Dutch East Indies. So far Devonian fossils have been definitely identified only from restricted areas of outcrop along the southern slope of the Snow Mountains in New Guinea. Many of the metamorphic rocks could be of this age but the absence of fossils in them precludes any age determination.

The *crystalline schists* were mostly laid down originally during Paleozoic and Mesozoic time. It should be noted here, however, that these schists are generally much younger than thought by the first explorers. Different stages of metamorphism have been observed and all rock types may be affected. Metamorphic rocks occur principally in Sumatra, Borneo, Celebes, the islands of the Timor-Ceram archipelago, Halmaheira and New Guinea.

*Carboniferous and Permian sediments* are fairly widespread but occur mostly in small patches over the whole Archipelago. In the district of Djambi in southern Sumatra, Upper Carboniferous and Low Permian are proven by the occurrence there of such fossils as fusulinids, brachiopods of the genus *Productus* and fossil plants like *Pecopteris*, *Lepidodendron*, *Sigillaria*, *Sphenophyllum*, *Calamites* and *Cordaites*. Lower Carboniferous beds containing *Spirifer* have been recorded from a single outcrop in the region of Sungei Landak. Fossiliferous Permo-Carboniferous strata are found also in the highlands of Padang in central Sumatra and in northern Sumatra as well. The above mentioned formations consist mostly of thin limestone and shale members interbedded with thick masses of lava, tuff and other igneous material of the same age. A similar interbedding has been observed in the Permo-Carboniferous of western Borneo. In Timor are found fossiliferous Permian outcrops such as limestone, marl and tuff. In this rich fossil fauna is a high percentage of species so far found only on Timor. The Permian ammonite fauna of Timor is the richest in the world and occurs in the field with an abundance of corals, bryozoa, blastoids, crinoids and brachiopods. Fossiliferous rocks of Permian and Carboniferous age have also been discovered on other islands of the Timor-Ceram archipelago and in several regions in the Snow Mountains of New Guinea. However, the extreme wealth of well-preserved fossils of this age seems to be entirely restricted to the classic localities found on the island of Timor.

*Triassic sediments*, occurring in a number of different facies, are found on many islands of the Dutch East Indies. In Sumatra fossiliferous deposits of clay shale, sandstone and limestone of Upper Triassic age cover fairly large areas. This is the case especially in northern Sumatra, in the highlands of Padang, and on the small islands of the Riouw archipelago south and east of Singapore. In western Borneo the Triassic formations, as generally developed, consist of tuffs and other volcanic rocks interbedded with terrestrial and marine deposits, the fossils of which afford the clue to the geologic age of the entire sequence. Clay shale, sandstone and limestone of Triassic age have also been reported from southeastern Celebes and the adjoining island of Buton. In the Moluccas the presence of Triassic sediments has been recorded by the discovery of fossils on Buru, Ceram, Ambon, and Misool. However, the Triassic of the Dutch East Indies became world-famous through the abundance and remarkable preservation of its fossils found in the sediments and tuffs of Timor. Here the formations of the Triassic are characterized by the development of different facies which often seem piled on top of each other by overthrust faults. Lower Triassic occurs only as the Cephalopodic facies in limestone complexes. Middle Triassic is represented by various facies groups such as shale and marl carrying *Daonella*, shale containing *Globigerina* and *Radiolaria* and, also, a sequence of sandstone and shale rather closely resembling the Flysch of the Alps. In the Upper Triassic we observe cephalopod limestone members interbedded in tuffs and often nearly exclusively built up from the remains of ammonites and nautiloids, as well as pelecypods, gastropods, brachiopods and the tests of foraminifera. The pelecypod facies of the Upper Triassic is characterized by limestone and shale containing *Halobia*, marls with the genus *Monotis* and siliceous limestone, shale and chert carrying abundant *Radiolaria*. The Fatu limestone facies consists of oolitic limestone, coral reefs and red and brown limestone containing ammonites, some gastropods and a few brachiopods. Finally, the so-called Flysch facies with *Daonella* consists of clay, shale, marl and breccias. The basic igneous rocks which have intruded the Upper Triassic are obviously of younger age. The pelecypod facies of the Upper Triassic are to be found on most of the other islands of the Timor archipelago but, again, without the richness of the Timor fauna.

*Jurassic* deposits found west of Makassar Strait are, for the most part, metamorphosed, whereas, in the eastern half of the Archipelago, the Jurassic rocks generally have been unaffected by metamorphic action. In Sumatra fossils are very scarce in partly or wholly altered phyllites and schists. Some poorly preserved belemnites, corals and pelecypods have been found there but the collections are too few, by far, to permit a subdivision of the Jurassic. In Java, schists in combination with basic eruptive rocks and radiolarian cherts are considered to be of doubtful Jurassic age. In western Borneo strata of Jurassic age occur in small patches as sandstone, shale and limestone. The limestone beds of this region contain a fairly rich fauna of ammonites including *Reineckia*, and of pelecypods including *Mytilus*, *Cardium*, *Pecten*, *Ostrea* and *Pholadomya* as well as corals and numerous plant remains. The so-called Danau formation with its radiolarian cherts may be partly of Jurassic age. In southeastern Celebes shales containing belemnites are definitely Jurassic in age. In the Moluccas most stages of the Jurassic are developed as dark calcareous shale with some chert, especially on the islands of Sula, Obi, Ceram and Buru. The most complete section outcrops on Misool. The rich fauna of these shales contain most of the typical Jurassic ammonites, such as *Macrocephalus*, *Oppelia*, *Stephanoceras*, etc., besides *Belemnites*, *Aucella*, *Inoceramus*, etc. In the Timor row of islands Jurassic is present as gray shale and limestone with numerous well preserved cephalopods, pelecypods and brachio-

pods. The Dogger is shown as ferruginous clay shale and calcareous shale. Finally Jurassic rocks have been discovered in many parts of Dutch New Guinea, especially north and south of the Snow Mountains and in the Vogelkop. The Bajocian and Callovian stages of the Jurassic occur in the neck of the Vogelkop, as proven by a moderately rich fauna including *Macrocephalus*, *Phylloceras* and *Stephanoceras*.

*Cretaceous.* — Lower Cretaceous has been definitely located only on the islands of Borneo, Sumatra, New Guinea and Sula, but Upper Cretaceous has been recognized on most of the islands of the Dutch East Indies and covers a substantial area. In the Djambi district of southern Sumatra, Lower Cretaceous shale, limestone and sandstone occur with *Neocomites*, *Turmannites*, *Osterella*, *Nerinea*, etc. Small, isolated outcrop areas, mostly Upper Cretaceous, are spread over the extent of the Barisan Mountains. Practically the entire known sequence of Cretaceous from Valanginian to Senonian, containing abundant, well preserved and characteristic fossils, has been discovered in two sections in western Borneo. This stratigraphic subdivision was made possible by close sampling and detailed survey of the two sections and subsequent study of their rich faunas which revealed the presence of more than twenty species of ammonites besides scores of pelecypods, echinoids, orbitoids, etc. The Cretaceous here is predominantly shale with occasional conglomerates, sandstones and marls. In the core of the mountains of southeastern Borneo considerable areas of Cretaceous limestone, with lesser amounts of conglomerate, sandstone and shale, are exposed. Here fossil determination has proved the presence of Cenomanian and Senonian. In Java, the Cretaceous is known only from a few isolated spots in which fossiliferous limestone is intercalated in between masses of serpentine, chlorite and mica schists. In the Sula Islands, Valanginian with *Phylloceras*, *Hoplites*, *Streblites*, etc., is developed in shale facies. In the Timor arc of islands richly fossiliferous, limestone and shale with chert concretions have been found in many places. The Alpine "couches rouges" and the Seewer limestone facies of Switzerland are found here with identical fauna and lithology. An Upper Cretaceous deep-sea facies, consisting of red clay shale containing manganese nodules with enclosed shark teeth and radiolaria, is known on Timor. In Celebes, Cretaceous beds consisting mostly of limestone, are found outcropping on the southeastern arm of the island. Smaller areas have been observed in other portions of Celebes on some of the adjacent islands. In Misool the Cretaceous is well exposed as limestone, clay, shale and calcareous sandstone containing a fairly rich fauna. On Halmaheira, Upper Cretaceous occurs as red and grey limestone interbedded with tufaceous layers. Finally, Lower Cretaceous is restricted to northeastern New Guinea while Upper Cretaceous occurs in many parts of the Snow Mountains and in the Vogelkop.

*Tertiary.* — The Tertiary represents by far the thickest sheet of sediments and covers more territory in the Dutch East Indies than any other group of formations, except perhaps the Quaternary. The European subdivisions (Eocene, Oligocene, Miocene and Pliocene) are somewhat difficult to apply in the Dutch East Indies, as the faunas developed here partly independently due to the severance of connection with the Mediterranean area since late Cretaceous time. Especially in Java subdivision was attempted by the percentage of living species in the different stages — the lower this percentage, the older the beds. Another method used the percentage of water in lignites — the higher the water percentage, the younger the age of the lignite. Both methods proved not very accurate and at present the stratigrapher works mainly with orbitoids and small foraminifera. The resulting subdivision is often marked by letters, "a" being the oldest and "g" the youngest stage of the Tertiary. The whole Tertiary column is divided into older Eogene and younger Neogene.

The Eogene of all Sumatra starts as a conglomerate, which grades upwards into sandstone and shale (with coal seams in the south), interbedded tuffs and some marine deposits near the top. The Neogene sediments, deposited in a deeper sea, are generally clay shale, marl and fossiliferous limestone. The marine conditions of sedimentation appear to have prevailed longer in the north than in the south where, in the upper Neogene, continental deposits became predominant with exceptionally thick coal seams (Palembang beds) and more and more volcanic tuffs which become the main facies of the Neogene in southernmost Sumatra.

In Java the Eogene outcrops cover less than 0.5% of the surface of the island as conglomerates, sandstones, coal seams, shale and limestones with Orbitoids. The Neogene is developed over very wide areas in different facies. Massive limestones occur in the north and south, while Globigerinae marls predominate in the east. Clayey marls and some sandstones make up the central part. In the Neogene, tufaceous layers become more and more frequent towards the top of the formation. The coarseness of the sediments clearly indicates that their source was from the north — the old Sunda shield. In eastern Java the terrestrial Trinil formation has produced a rich assemblage of fossil bones of Mammalia including the famous *Pithecanthropus erectus*, presumably the oldest remains of fossil man.

The Eogene of western Borneo is composed of fossiliferous sandstone and sandy shales, while in SE Borneo it consists of orbitoid limestone, marl and green sandstone with coal seams. Further, the Eogene limestones of the mainland of Dutch NE Borneo are very fossiliferous and were used mostly for subdivision of the Tertiary. The Neogene of western Borneo has so far been found developed in marine facies in one spot only. On the other hand, it covers wide stretches in eastern Borneo with a maximum thickness of 5000–8000 m. It consists mostly of shale, clay, clayey sandstone (often finely bedded), coal seams, few tuff layers and occasional limestones occurring as thin beds or massive reefs. In certain regions, such as Kutei, lignite seams are so frequent, that up to 10% of the formation is coal, besides containing numerous beds of carboniferous clay with plant remains and silicified wood.

The Tertiary of Celebes is characterized by a very high percentage of volcanic material in the form of tuffs, liparites and basalts. The Eogene in south Celebes begins with conglomerates and a sandstone series with a few coal seams followed by a thin limestone sequence. The Neogene

appears to start in the upper portion of the same limestone complex and is followed in SE Celebes by marine shale and clay with some coal seams, indicating terrestrial interruptions of the marine sedimentation. This "volcanic Tertiary" of Celebes occurs in a number of small, isolated or partly connected, basins.

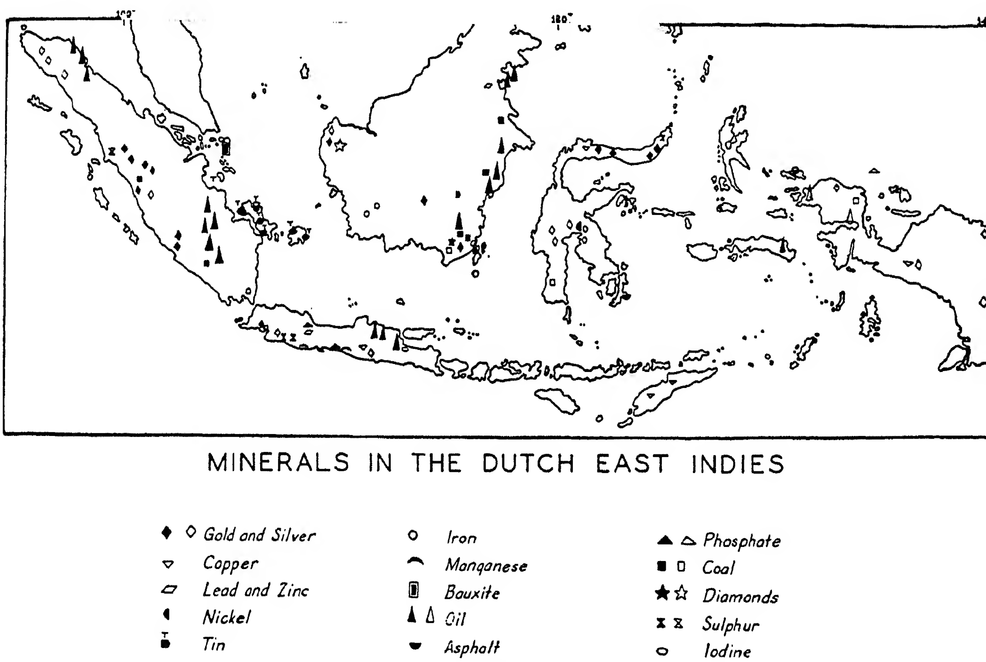
*New Guinea.* — Eogene has been found in a number of places, mostly in the form of creamy obitoid limestone. Neogene covers large portions of the island and consists of sandstones, shale, conglomerates, some lignite seams, marls, massive and extensive limestones and globigerina marls. The Neogene has been reported to be at least 5000 m. thick on the northern coast, and is interbedded locally with volcanic deposits.

The Tertiary formations of the other islands are relatively thin and consist of massive limestone over limited areas.

rocks have representatives from Devonian to the present time. Description of those igneous rocks is impossible within the scope of a few pages, but some will be referred to in the chapter on economic geology.

### VI. ECONOMIC GEOLOGY

The importance of the Dutch East Indies as a source of mineral raw materials, hydrocarbons, coal and metalliferous ores has been steadily growing during the last few decades. At present, the outstanding products are petroleum, tin, bauxite, gold, silver, and coal. Other products which have been in the stage of limited exploitation or prospecting include iron, copper, nickel, lead, manganese, monazite sand, platinum, tungsten, asphalt, phosphate, sulfur, iodine, diamonds, as well as limestone, sand, clay, gravel and kaolin.




—FIGURE 86—

*Quaternary* deposits cover a very large portion of the Dutch East Indies as sand, gravel, mud, clay, corals, tuffs and other recent eruptiva. Of special interest are extensive thick gravel terraces along the foot of the Snow Mountains in New Guinea. In the latest glacial periods these mountains must have been covered with at least the same amount of ice and snow as now covers the Alps in summer time, as proven by the beautifully glaciated topography in high altitudes and the presence of moraines down to 2000 m. Quaternary Coral reefs of all sorts play an important part especially in the eastern half of the Archipelago, where many are found elevated to considerable altitudes, often exceeding 1000 m.

*Igneous Rock.* — Igneous and volcanic rocks are spread over the whole Archipelago and occur in practically all varieties from massive granites to loose ashes. These intrusive and extrusive

*Tin.* — Tin is found in the Dutch East Indies in the southernmost part of the east Asian tin belt. Here it includes all islands of the Riouw archipelago, Banka, Billiton, a narrow strip of the west coast of Sumatra and a small portion of W. Borneo. The tin ore was formed by older Mesozoic granitic intrusions into younger Mesozoic sandstones, conglomerates, clay shale and interbedded Diabase. The tin ore has partly remained in the granite itself, but a portion has been concentrated in the metamorphosed sediments at the contact, mostly as cassiterite in quartz veins. Especially on Billiton a number of workable ore lodes have been discovered which, in addition to tin ore, contain a large number of other minerals. Erosion washed the tin ore down from the granite hills and it accumulated at the bottom of the alluvium in the valleys, directly above the bedrock. The concentration of ore is obviously very irregular, but

these alluvial deposits are the richest found so far and have accounted for the bulk of the production. In Pleistocene time the lower portion of the valleys was flooded by the rising sea and as they still contain tin ore for some distance out from the present shore, they can be exploited with success by sea-going dredges. Tin mining started in Banka in the 18th century and in Billiton in 1852. The mines are in the hands of the Dutch government (Banka), private companies (Billiton and Sinkep), while on the West coast of Sumatra natives wash out a few hundred tons per year. Tin deposits have been discovered on many of the smaller islands of the Riouw archipelago but exploitation has not started there as yet. The tin deposits of western Borneo are only small traces of tin ore found in rivers without commercial value so far. Tin is one of the outstanding mineral products of the Dutch East Indies and it has supplied about 20% of the world's annual production. The total output for the years 1939, 1940 and 1941 was 28,200, 44,563 and 52,000 tons, second in value only to rubber and oil in the Dutch East Indies exports.

*Gold and silver.* — Gold and silver in moderate quantities have been mined since long ago in the Dutch East Indies. Gold and silver in association with many other ores occur, as a rule, in quartz veins in metamorphosed rocks. The intrusive igneous rocks are mainly andesites of Tertiary age. Concentration of gold and silver are often observed at the intersection of two or more fault systems. Native gold in quartz has been discovered mainly in western Sumatra. To a lesser degree it is found in northern Sumatra, Java, western and southern Borneo, different regions of Celebes and Timor. Recently, an interesting occurrence has been discovered in the Carstensz massif in New Guinea which may be fairly rich, but is hardly workable yet on account of its location high up in the wild mountains. In most rivers of Sumatra, southern Borneo, Java, Celebes and Timor, gold is also found in placers. However, its concentration as a rule is very poor, so that only native prospectors can make a meager living by working these deposits. Therefore large exploitations with dredgers similar to those of Papua are at present unprofitable in the Dutch East Indies. The total production reached its peak in 1925 with 4200 kg. of gold and 75,000 kg. of silver and, with the exception of the last few years, has been definitely on the decline. The bulk of the production comes from about ten European companies and the remainder from native enterprises. The yield for 1937, 1938 and 1939 was 1730, 2378 and 2525 kg. of gold and 15,555, 18,018 and 19,223 kg. of silver.

*Iron ore.* — Iron ore is found in small quantities in igneous and metamorphic rocks throughout the Archipelago. In only two regions, central Celebes and SE Borneo, have large quantities of fair quality ore been discovered. In the lake area of central Celebes the ore is the lateritic product of the weathering of basic igneous rocks, mostly peridotites. The laterite has a thickness of 4–22.5 m. with an average of about 11.5 m. As a rule the deposits have a thin crust of rock ore at the surface, underlaid by soft clay ore with occasional blocks of rock ore. The iron ore reserves of central Celebes, covering over 4000 sq. km., are enormous and are estimated to exceed the one billion ton mark. A part of this area, in the vicinity of Malili, has been studied more in detail. This so-called Larona Field was calculated to contain a clay ore reserve of 500,000,000 tons and 15,000,000 tons of rock ore by an average iron content of 49%, the $Fe_2O_3$ percentage of the laterite being about 72%, for both the soft and hard grades. The iron ores, also $Fe_2O_3$, on the islands and mainland of SE Borneo are of a similar lateritic origin from underlying serpentine, covering it as an irregular thin sheet over vast areas. Here the average iron content is about 46%. The estimated ore reserves of SE Borneo are as follows: mainland 170,000,000, Pulu Suwangi 250,000, Pulu Danawa 7,500,000 and Pulu Sebukan 300,000,000 tons. Deposits of laterite of unknown size have been observed overlying basic igneous rocks in several localities of the eastern Archipelago as well as on the tin islands. In this connection the black beach sands of southern Java and Bali are worth mentioning. This black sand is magnetitic and titanitic iron ore of volcanic origin, washed down to the sea by rivers and concentrated along the beaches in appreciable quantities by the continuous action of the waves.

The large iron ore deposits in Borneo and Celebes have so far not been touched, except by the recently inaugurated nickel mines in the same area of Celebes. In the past, several projects have been discussed and considered for establishing a local iron industry in Borneo or Celebes, but these plans have not materialized as yet.

*Nickel ore.* — Nickel ore has been the latest mining product of the Dutch East Indies, starting on a commercial basis in 1938. The nickel ore is found in the lake area of central Celebes associated with the residual iron ores. The best ore with a percentage of NiO up to 20% occurs as filling of cracks and loose weathered blocks on the surface. The iron ores, which form the bulk of these huge deposits, also contain, as a rule, one percent, or more, of NiO. The excavating is done in open pits and the rapidly rising output for the years 1938, 1939 and 1940 reached 20,000, 23,535 and 55,500 tons, all of which was exported to Europe. In spite of the low NiO content of the Celebes ores the prospects of this branch of mining look bright for the future in view of the very large reserves present. (*See* iron.) The erection of smelters in Celebes was seriously considered before the outbreak of the war.

*Platinum.* — Platinum is washed out in very small quantities from the placers in Martapura in SE Borneo, together with diamonds and gold. Furthermore, traces of platinum have been reported from placers in Atjeh and from metamorphosed limestones in central Sumatra as a byproduct of the Bengkalis gold mines. The output of the latter for 1938 and 1939 was only 646 and 873 grams.

*Tungsten ore.* — Tungsten ore is one of the rare minerals of the tinbelt, where it occurs in greisen in granite, mainly on the islands of Billiton, Singkep and Banka. At present the bulk of the production comes from Billiton and totals, for the years 1937, 1938 and 1939 to 0.4, 0.4 and 3.5 tons.

*Lead ore.* — Lead ore is found in southern Sumatra in connection with Tertiary granite dykes. The deposits are of a very restricted nature and the total production for 1938 and 1939 reached only 50 and 60 tons respectively.

*Manganese ore.* — Manganese ore has for many years been mined in Keliripan in the province of Jogjakarta in central Java and has remained the

only occurrence of importance in the Dutch East Indies. The soft ore is found as an irregular bed between Neogene marl and limestone and contains a large number of shark teeth. The ore is fairly high grade with 40–95% $MnO_2$, averaging 75%. Manganese ore was further discovered in small veins in the Preanger in western Java. The production in Keliripan for the years 1937, 1938 and 1939 was reported to be 11,083, 9687 and 12,074 tons. Mining has been going on here for many years with a record production of over 24,000 tons in 1928.

*Monazite sand.* — Monazite is produced as a by-product in the tin exploitation on Singkep with 370, 393 and 123 tons in 1937, 1938 and 1939.

*Copper ore.* — Copper ore has been found in many parts of the Dutch East Indies but nowhere in commercial quantities. Copper ores occur in Tertiary granite dykes and adjacent rocks, as impregnations in contact metamorphosed rocks and associated with young Tertiary andesites. Such occurrences have been reported from Sumatra, Java, western Borneo, Celebes, the Moluccas and, recently, from New Guinea. The present small copper production is a by-product of the gold mines of Muara Sisipongi in southern Sumatra and was for the years of 1937, 1938 and 1939 to 49, 93 and 94 tons of metallic copper.

*Bauxite.* — Bauxite is a relatively recent addition to the mineral wealth of the Dutch East Indies. About 10 years ago deposits of bauxite were discovered on different islands of the tin belt in the Riouw archipelago. The aluminum ore here is a weathering product of granite and diorite and covers large areas of the islands to a shallow depth and in varying concentration. The reserves are considerable and should guarantee production for many years to come. Exploitation has been started on the east coast of the island of Bintan and on the adjoining small islands. The ore was dug mechanically by diesel shovels, sorted and dried locally, whence it was shipped abroad. The mines of Bintan, in the years 1937, 1938 and 1939, yielded 198,970, 245,354 and 230,668 tons of bauxite. This production together with the output of Surinam in the Dutch West Indies represented before the war about 20% of the world's bauxite production. The industry will be still more important after the war when the projected aluminum plants for processing of the ore in the Dutch East Indies will be put into operation.

*Diamonds.* — Up to now diamonds have been found only in the southern part of Borneo. In Martapura in SE Borneo the diamond placers are located in the lower-most portion of a gravel terrace. The probable source rocks are peridotite and serpentine of Cenomanian age outcropping in the Martapura mountains up stream from the placers. The deposits in western Borneo are in the valleys of the Landak and Sakajam rivers and the diamonds appear to have originated from an olivine rock. The quality of the diamonds is as a rule not very high, having generally a slight yellow tint and the majority of the stones are small. The industry is entirely in the hands of Chinese and natives who operate a crude cutting and polishing plant in Martapura. It is one of the oldest mining industries in the Dutch East Indies, but all efforts to develop it to a major asset of the country have failed because of insufficient concentration of the diamonds in the gravel beds. Besides clear diamonds, very small quantities of black diamonds, platinum, gold, topaz, ruby, etc. are washed out by primitive panning. The output for the years 1937, 1938 and 1939 was calculated to be 951, 1579 and 2287 carats.

*Iodine.* — Traces of iodine have been found in practically all saltwater springs and mudvolcanoes (Borneo, New Guinea and Timor) throughout the Archipelago, but only in eastern Java the concentration is such that it could be developed commercially. The brines of the petroleum belt of Java between Semarang and Surabaya contain up to 100–140 milligrams of iodine natrium per liter. This saltwater, together with some oil and gas, is pumped from wells on the Bulu Petiken anticline directly south of Surabaya. The product is used for the manufacturing of copper iodide ($Cu_2I_2$) which is exported from Java. Accurate production figures were not published for the last few years but probably exceeded 200 tons per year. The reserves are extremely large considering that the present production is obtained from a single anticline only. The export of $Cu_2I_2$ for 1937, 1938 and 1939 respectively was 116, 62 and 37 tons.

*Sulphur.* — Sulphur deposits are found on most active volcanoes in the Dutch East Indies. However large quantities of sulphur have been formed and preserved only in volcanoes in an intensive solfatara stage, emanating vapors which are condensed in the mud and water of their craters. Volcanoes in violent eruption destroy the sulphur, and it is removed by erosion from the non-active ones. The government of the Dutch East Indies has explored by intensive shallow drilling a number of craters, mostly in Java. It proved that to an average depth of 10 m., the crater mud contained about 50% pure sulphur, the percentage rapidly decreasing with depth. The sulphur reserves of many volcanoes were calculated as follows: Kawah Putih (West Java) 150,000 tons of ore (sulphur with ashes, stones and mud) with 70% sulphur, Tangkuban Prahu (north of Bandung) 500,000 tons with 55% sulphur, Merapi (central Java) 240,000, 320,000 tons with 55% and 26% sulphur in different lake terraces, Mahawu near Menado (Celebes) with 130,000 tons with 74% sulphur, etc. The total calculated ore reserves of the Dutch East Indies is well over 2,000,000 tons with over 1,000,000 tons of pure sulphur. Sulphur is probably the only mineral raw material which is formed by nature through solfatara activity as fast as exploited by man. The locations of the mines at the top of high volcanoes, the danger of gases and sudden eruptions and the difficult transportation have so far prevented exploitation on a large scale. The bulk of the present production is obtained from the Kawah Putih (western Java) with small quantities from Malang (eastern Java) and Langoan (Menado, Celebes). The yearly output for 1937, 1938 and 1939 respectively was 12,674, 16,242 and 17,520 tons, of which the greater portion was exported.

*Phosphatic limestone.* — Phosphatic limestone has so far been discovered only in Java in the Tertiary limestone area of the Kromong mountains north of Cheribon in central Java as well as along the coast north of Semarang. Recently, another phosphate mine was opened in Karangbolong on the south coast of Java. The calcareous limestone, originating from guano deposited on top of the rock, has apparently been transformed by phosphoric acid into phosphate to a

certain depth. Furthermore, phosphate has been deposited in veins and cracks of the bedrock. On the average, the limestone contains 28% $P_2O_5$ with 55% $CaCO_3$ besides small percentages of iron and aluminum oxides. At the beginning of exploration the reserves of ore were considered insignificant, but the latest production figures prove the presence of considerable quantities of phosphate, especially in the region of Cheribon. Throughout the Dutch East Indies with its more than 10,000 islands, it is remarkable that so far very few and rather small recent guano deposits have been located. It is possible that the number of birds is insufficient or the precipitation too high, washing away their product. Small guano deposits are found on Bears Island south of Celebes, Moromahu in the Tukang Besi group, Lembe in NE Celebes, Pulu Batu to the west of Flores and the northwesternmost small island of the Schouten group north of New Guinea. No guano is mined at the present time.

The exploitation of the phosphate is in the hands of four European companies which crush it into powder locally and sell it in Java as fertilizer. The production for the years 1937, 1938 and 1939 were 26,167, 33,113 and 18,777 tons.

*Limestone.* — Limestone is obtained from many quarries, both large and small, for construction purposes and the manufacturing of cement. The age of the limestone is Tertiary as a rule with a few Quaternary and Mesozoic sources. During 1937, 1938 and 1939 respectively 424,680, 608,470 and 639,880 tons of limestone were excavated in surface quarries in Java and Sumatra. The above figures include marls as well, but not the very insignificant production of the remainder of the Dutch East Indies.

*Clay.* — Clay is dug in pits in Java, Sumatra and Celebes for the manufacturing of bricks, tiles and pottery. The clay is as a rule of young Tertiary or Quaternary origin. During 1937, 1938 and 1939 respectively 19,420, 31,780 and 31,770 tons of clay were produced. These figures include only the output for the larger factories and do not take into consideration the innumerable small native business enterprises, which probably would at least double the above mentioned figures.

*Kaolin.* — A few kaolin pits, for the manufacturing of finer pottery, etc., are in operation in western and central Java, southern Sumatra and western Borneo. In Java the kaolin is the white weathering product of dacitic rock. The moderate output for the years 1937, 1938 and 1939 amounted to 780, 3700 and 2810 tons.

*Tras.* — This is the name of a special sort of tuff in a certain stage of weathering. The tuff is ground to a fine dry powder, which, when mixed with water, becomes very hard in a short time and thus is widely used as natural mortar in Java especially. The best quality originates from weathered leucitic basaltic tuffs of the volcano Muria north of Semarang in eastern Java and from andesitic tuffs near Bandung. The official government statistics for the years 1937, 1938 and 1939 report a total output of 1330, 1650 and 1900 tons respectively.

*Petroleum.* — Oil traces are found all over the Archipelago in the form of seepages, bituminous impregnations and mudvolcanoes. This fact has induced enterprising Dutch companies to start test drilling, and the first actually producing field was discovered South of Surabaya in Java as far back as 1889. Since then a large number of fields have been developed in northern and southern Sumatra, eastern Java and eastern Borneo mostly as moderate producers. A single field of modest capacity is being worked in Ceram in the Moluccas. Throughout the Dutch East Indies the oil is recovered from late Tertiary sediments accumulated in narrow long anticlines. Up to date no commercial quantities of petroleum have been found in other structures than simple or complex anticlines. Many large oil deposits must have been destroyed in the past by erosion, which has exposed the oil-bearing strata along the anticlinal axes in many areas.

In northern Sumatra there are, at present, 10 fields producing from sands in upper Tertiary beds, overlying a thick mass of clay and marl, called "grensklei." In southern Sumatra far more than 100 anticlines have been mapped in the Tertiary oil basin of Palembang. Of this number 30 structures so far have been proven to be productive. The oil has accumulated in the highest domes of trunk-folded, long anticlines in the so-called Palembang beds consisting of clay, sand, coal and tuff. Here is situated what is probably the richest individual oil pool in the Dutch East Indies, the Talang Akar field with a yearly output of over 800,000 tons. In eastern Java 14 producing oil fields are in operation on generally steep and narrow anticlines. The oil is stored in young Tertiary sands interbedded by clay, marl and shale. Eastern Borneo has developed 10 oil fields to date, of which Sanga Sanga and Tarakan are by far the most prolific. The oil is found in Kutei in long narrow structures and in Tarakan in rather flat broad domes. The oil-bearing formation in Kutei and Tarakan consists of a sequence of young Tertiary clay, shale, lignite and sands. All these oil basins are part of the same geosyncline and constitute the southeastern extension of the Burma oil belt. The only producing field outside this zone is situated on the eastern coast of Ceram in Bula. Moderate production is here obtained along the sea shore, where flat-lying sediments of late Pliocene or early Pleistocene age are exposed. For the western fields the source rocks of the oil are probably marls and clays within the younger Tertiary. In southern Borneo some oil was generated in Eocene time and in the Moluccas in addition to the Tertiary source a Mesozoic origin of some petroleum is suggested by numerous oil and gas emanations in Triassic, Jurassic and Cretaceous beds.

The type of the crude oil varies widely from pool to pool and also within the same individual field according to the depth of the oil sands. Tarakan, for example, yields a heavy asphaltic oil without any light fractions and can therefore be used as fuel without further treatment. In northern Sumatra some fields produce very light oil with high gasoline content and Java is well known for its crude with high percentage of wax.

The 65 operating fields of the Dutch East Indies produced only about 3% of the world's output of petroleum in 1939 but their location in the oil-hungry Far East makes them doubly valuable. The production of crude oil for the years 1938, 1939 and 1940 was 7,398,144, 7,948,694 and 7,938,000 tons of 1000 Kgs. (1 ton about 7 bbls.). The production for the different islands is as follows:

| | 1936 | % | 1938 | % | 1940 | % |
|---|---|---|---|---|---|---|
| Java & Madura | 449,000 tons | 7.8 | 993,000 tons | 12.6 | 839,000 tons | 10.6 |
| Sumatra | 4,115,000 " | 63.9 | 4,663,000 " | 63. | 5,209,000 " | 65.6 |
| Borneo | 1,774,000 " | 27.5 | 1,720,000 " | 23.3 | 1,793,000 " | 22.6 |
| Ceram | 50,000 " | 0.7 | 82,000 " | 1.1 | 98,000 " | 1.2 |

Practically the entire production was processed in seven modern refineries located in Sumatra, Java and Borneo.

In recent years, intensive exploration was carried out in Atjeh, central Sumatra, western Java, southern Borneo, Celebes and New Guinea. Positive results so far have been reported only from southern Borneo, where in 1939 a production of 4641 tons was obtained.*

*Asphaltic rocks.* — Asphaltic rocks occur in different parts of the island of Buton, adjoining southern Celebes, as black bituminous limestones and marls. The age of the generally horizontal limestone beds are either Quaternary, uplifted coral terraces, or Tertiary, but the bituminous impregnations are derived most probably from underlying Jurassic and Triassic limestones, marls and sandstones. During this vertical oil migration, all light fractions of petroleum have evaporated, leaving only black asphalt as residue in the rock. This asphaltic limestone is at present exploited in the SE corner of Buton near the harbor of Pasar Wadjo in open quarries and in tunnels. The reserves of asphaltic limestone and marls with sufficient impregnation for economic use are estimated to be over 100,000,000 tons. In small plants in Pasar Wadjo and Batavia in Java the rocks are ground to powder and prepared for use as road cover. The production during the years 1937, 1938 and 1939 was 2199, 6224 and 5383 tons, which was sold mostly in Java.

*Coal.* — All the principal coal basins in the Dutch East Indies are of Tertiary age, either Eocene or Miocene-Pliocene. The Ombilin field in central Sumatra and the Pulu Laut area in SE Borneo are the two outstanding Eocene coal basins. The first covers an area of about 100 square kilometers and contains a number of coal seams 0.5 to 8 m. thick. The Pulu Laut coal, mined on a steep anticline, is of poorer quality than Ombilin coal, having higher percentage of ashes and water. Therefore this mine was closed a number of years ago. The visible reserves of Eocene coal are estimated at many hundred million tons. The Miocene-Pliocene lignite basins are much larger and cover southern and central Sumatra, part of western Java, many stretches of eastern Borneo, Celebes and New Guinea. Coal formations with over 100 beds of lignite and carboniferous clay are reported from Kutei in E. Borneo. The lignite reserves of the Dutch East Indies amount certainly to many billion tons and may become more valuable in the future. The quality of this lignite is usually reduced by too high water and ash content. However, in some fields in southern Sumatra the lignite has been transformed into excellent coal by the slow metamorphism of intruding andesite plugs. The result is a fuel with a caloric value of 7000–8500, which competes on the eastern market with imported coal of Carboniferous age. The government owned Ombilin and Bukit Asem mines produce the greater part of coal mined in the Dutch East Indies. The K. P. M., the local large steamship company, operates its own coal mines in Parapattan in eastern Borneo to provide fuel for its ships. The native coal mine industry of Borneo is run by Chinese on the middle Barito and Mahakam rivers. Outside of Borneo and Sumatra coal is mined by natives on a small scale and for local use only. The total production of coal from all sources for the years 1938, 1939 and 1940 amounted to 1,456,647, 1,780,632 and 2,000,000 tons.

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# A BOTANICAL EXPLORATION TRIP IN SOUTH SUMATRA

*by*

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INTRODUCTION: — Up to recent years our knowledge of the flora of the Ranau region remained rather scanty, though it must be considered a rather important locality for the study of those Sumatran plants which are found in the Barisan mountain chain and fail to occur in W. Java, i.e. species which do not cross the Sunda Straits. The trip was made in search of those plants. It is to be regretted that volcanoes which attain 3000 in altitude or more do not occur S. of G. Dempo [1] if we neglect G. Patah

* Since, E. W. BELTZ has published in the *Bulletin of the American Association of Petroleum Geologists* of October 1944 an article on "Principal sedimentary basins in the East Indies." He mentions, without any details, two recently discovered oil fields in New Guinea and also two in central Sumatra.

† Reprinted from the author's "Report of a Botanical Trip to the Ranau Region, South Sumatra," Bull. Jard. Bot. Buitenz. III, 13:1–21 (1933).

[1] G. = goenoeng = mountain = Bt = boekit.

just S. of the latter. First we have Bt Daoen [2] reaching ca 2467 m, and in the Ranau region only one volcano, *viz*. G. Pesagi, exceeds 2000 m and in the very S. of the Lampoeng Districts only the Tanggamoes complex attains this height. Also in the Western part of Java no mountains which surpass the 3000 m contour occur W. of the Gedeh-complex, only G. Salak attaining ca 2200 m. In Bantam, the westernmost Residency of Java, only G. Karang reaches 1775 m above sealevel. So between G. Dempo and G. Gedeh in recent times a wide gap of lowland and mountainous country of medium altitude is found ca 500 km in length. It is true that 3000 m is not the lowest limit for typical mountain plants. That depends, apart from the height of the whole mountain complex, on the character of the topography, soil and hence of the vegetation and on the definition of "mountain plant." If there are bogs and grassy plains at altitudes lower than 3000 m, typical mountain plants descend to 2000 and even to 1700 m, as is the case in the Res. Priangan in W. Java, Mt Dieng in M. Java, the Idjen and Jang Plateaus in E. Java and the Toba region in M. Sumatra. Also near craters, along steep slopes, on old lava streams and in gullies mountain plants are able to descend locally. In all the above-named localities, however, there are neighbouring mountains which attain a greater height. That is the rule of the so-called "Massenerhebung" which holds good for the tropics as well as for the temperate zones. The higher the mountain complex the wider the altitudinal zones of the mountain plants. This is a.o. illustrated by Mr. C. A. BACKER with the distribution of *Albizzia montana* BTH. He cites (*in msc.*) the distribution of it in Java as follows: "From W. to E. Java on volcanoes which are at least 2500 m high or form part of a mountain group of which the highest peaks attain that altitude; on these mountains common between 1800 and 3100 m, sometimes descending to 1100 m." As has been already stated no such high mountain groups occur between G. Gedeh and G. Dempo and also the aberrant localities mentioned above, such as craters, etc. are absent there. All mountain ridges are forest clad and only a few mountain herbs have established themselves in the low scrubby forest on the highest ridges. Hence, the region was not very promising for the study of mountain plants, but species occurring in JUNGHUHN's zones II and III, *i.e.* between 650 and 1500 and between 1500 and 2500 m were to be expected. I have not collected anything of importance lower than the Ranau [3] which is situated at ca 540 m above sealevel.

I am very much indebted to the late Mr. S. LEDEBOER, then head manager of the South Sumatra Land Syndicate and to Mr. W. F. RUDIN, the manager of the coffee plantation Sepatoehoe; without their valuable help and facilities rendered to me it would have been impossible to get satisfying results.

I must express my sincerest thanks to Mr. M. R. HENDERSON, Curator of the Botanic Gardens, Singapore, for reading and correcting this paper and to Dr. H. R. A. MULLER, Mycologist at the Institute for Plant Diseases, Buitenzorg, for various information.

TOPOGRAPHY AND GEOLOGY: — The Ranau is one of the four largest lakes of Sumatra [4] covering ca 126 sq. km, and is situated at about 540 m above sealevel. It is more or less kidney-shaped and is dominated by the fine cone of G. Seminoeng situated in the centre of the kidney reaching 1340 m above the lake (1881 m alt.). Below the waterlevel the slopes of the basin fall rather steeply to ca 200 m. As the greatest depth is ca 229 m, the lake bottom is rather flat and the water very deep (see map by VERBEEK).[5] Around the lake the hills rise rather steeply up to 200 m; the shore is often rocky or consists of a narrow sandy beach. In the SW. the Wai Warkoe pours its waters forth into the Ranau of which the outlet is in the NW. by means of the broad and shallow Koeala. Near the southern side at the N.-foot of G. Seminoeng there are some hot springs near the surface of the lake. The chemical composition of this hot water has been studied by J. J. ALTHEER.[6] It contains much $SiO_2$ and Cl, a trace of $H_2SO_4$, and the gasses which it contains in solution are $H_2S$ and $CO_2$. He gives the temperature as 125° F. If these hot springs represent a trace of volcanic action it is the only recent volcanic phenomenon in the whole of the Ranau region.[7] All geologists agree that G. Seminoeng is younger than G. Pesagi and is very young geologically speaking. The slopes along the Ranau are steepest at its western border; they culminate in the Bt Pakiwang ridges attaining ca 1531 m altitude. Along the northern border of the Ranau there is a large undulating plateau which consists of ca 200 m thick, fertile tuff-strata descending gradually towards the North, the highest point of which is reached in Sepatoehoe ca 750 m alt. where large coffee plantations have been made by the Syndicate. Along the eastern border the hills rise up to ca 500 m above the lake and the steep road which can be climbed only by powerful cars leads to an extensive undulating plateau at about 1000 m altitude, surrounded by three peaks, *viz*. G. Raja (1643 m) in the N., G. Koekoesan (1779 m) in the S. and G. Pesagi (2232 m) the highest of the three, in the SE. On this plateau the large tea plantation G. Raja has been established recently by the Syndicate.

The geology of the Ranau region is fairly well known. However there are two opinions about the origin of the Ranau itself. VERBEEK [8] supposes that the tuff-strata of the Belalau Plateau have been supplied by G. Pesagi which had been heavily eroded after its extinction and must have been a lofty peak in some earlier period. The enormous pumice- and tuff-plateau which surrounds the lake and consists of ca 200 m thick strata he derives from an eruption point where now the Ranau is situated. After the very active period, during which the tuff was ejected, this

[2] *Oe* is pronounced as *ou* in would.

[3] *Ranau* means already lake, hence it is a pleonasm to speak of "Lake Ranau."

[4] The others are Lake Toba, Manindjau and Singkarak.

[5] R. D. M. VERBEEK, Aanvullingen en verbeteringen bij de topographische en geologische beschrijving van Zuid Sumatra, voorkomende in het Jaarboek van het Mijnwezen in Ned. Indië 1881 deel 1 (Jaarboek Mijnwezen Ned. Ind. 16 (1887) Techn. en Admin. gedeelte p. 129–154).

[6] Het water van Seminoeng (Natuurk. Tijdschr. Ned. Ind. 10 (1856) 463–464).

[7] After this manuscript had been written most terrible earthquakes have ravaged the Ranau region at the end of June 1933, especially along some tectonic fracture lines. This catastrophe was accompanied by a rain of ashes from an outblown swamp. Part of the top of G. Pesagi has precipitated.

[8] R. D. M. VERBEEK, Topographische en geologische beschrijving van Zuid Sumatra (Jaarboek Mijnwezen Ned. Ind. 10 (1881) deel 1 Verhandelingen, p. 1–213, map and drawings).

broke down, which resulted in the formation of a great lake, the Ranau. He supposes the Seminoeng to be a secondary eruption-point which was built up after the formation of the Ranau. If this secondary cone had not existed, the Ranau would have shown the circumference of a circle. The tuff must — according to him — have been deposited partly in water. It is very fertile owing to porosity and admixture of humus and on this soil the well-known Ranau tobacco was formerly cultivated but now has been almost entirely replaced by coffee. Recently tobacco was planted again.

However, PHILLIPPI[9] asserts that the Ranau originated by a tectonic depression, formed in the early Neogene in a large anticline. He believes the form of the Ranau — if for a moment the Seminoeng cone is neglected — to be a rectangle rather than a circle and supposes its sides to have been formed along tectonic fracture-lines which should fit into the other tectonic features of South Sumatra. He also thinks the Seminoeng to be of rather recent origin though no eruptions from the last centuries are known; it is built up of a porous material and is almost lacking in streams. He already remarks that the cultivated area has crept up its slopes as high as a little above 1300 m altitude.

VAN BEMMELEN[10] on the other hand supports the theory of VERBEEK and supposes a vaulting to have taken place in the Quarternary during which the large ejections of tuff-material took place after which the vault broke down and gave way to the formation of the Ranau. The same view he holds for the origin of Lake Toba.

VAN TUYN & WESTERVELD,[11] again, oppose the theory of VAN BEMMELEN.

So it seems that the final conclusion about the origin of the Ranau is not yet reached.

The inhabitants of the Ranau region are generally prosperous.[12] Their houses are large, built with large, fine timber, and according to local information sometimes cost more than *f* 5000, —. For a long time past the Ranau Malays have had valuable crops, tobacco, cotton and nowadays coffee, which on the fertile soil, have made them comparatively wealthy.[13] Their bearing is rather haughty, and only under pressure is it possible to get them to act as guides and then at an exorbitant daily rate of pay. This circumstance is very striking if one is accustomed to the cheap and willing labour in Java. Moreover, for some years they were upset over extensive tracts of land (on Mt Seminoeng) which the Syndicate had obtained from the Government, saying that they had not enough space for their own crops. Recently these grounds have been abandoned by the Syndicate and given back to the Government. It is a fact, however, that the Malays always try to get the virgin soil of untouched forest. They burn it, plant rice or vegetables, and after two years plant coffee in the clearings. Subsequently, however, they take no care of the plantations, and many of them change within a few years into high secondary growth, with the result that the coffee crop is collected under many difficulties and in a very primitive manner. Some of the native gardens do seem to be kept clean and weeded, but in general those are more recent ones and those belonging to richer people. I have walked along extensive abandoned coffee plantations which had grown up into impenetrable thickets and dense secondary forest. The lack of any care for the gardens is of course especially pronounced in years when the prices are low. I got the impression that — as in many localities in the Archipelago — a predatory cultivation is practised, with this temporary "ladang" system. I met with extensive secondary forests and abandoned coffee plantations between the Koeala and Bt Pakiwang, E. of G. Raja and around and on G. Seminoeng; *Lantana Camara* L. especially is one of the plants which take possession of those grounds and keep it in more or less good condition; *Imperata* is extremely rare in the Ranau-region and has nowhere an important share in the vegetation. Indeed even in Palembang where one expects to meet with endless a l a n g a l a n g plains I observed that they form only a rather narrow strip along the railway (and are often set on fire which is of course advantageous for its existence) and even there many young specimens of *Dillenia* and others were seen to penetrate from the border of the secondary growth into the l a l a n g. Dr. H. R. A. MULLER who has gained extensive field-knowledge of S. Sumatra informed me that in the deforested Pasemah Lands large areas are covered by a l a n g a l a n g, as is the case in some other localities in Palembang. In the Lampong Districts he observed a l a n g a l a n g fields which seem to be temporary on the fertile grounds but are only very slowly being replaced by secondary forest on the lower sandy soil.

EARLIER COLLECTIONS: — According to MIQUEL[14] the botanist CHARLES MILLER made an excursion in the Benkoelen Residency in 1770 and so did CHARLES CAMPBELL (?1801). I do not know whether they made collections, which localities they visited or whether their collections were preserved.

The well-known botanist WILLIAM JACK collected from 1819 to 1822 N. of the Ranau region in the Res. of Benkoelen; his valuable collection perished in the "Fame" catastrophe; descriptions of his plants were edited in his "Malay Miscellanies."

In 1818 TH. HORSFIELD & RAFFLES collected in Benkoelen.

The well-known former Curator of the Buitenzorg Botanic Gardens, J. E. TEYSMANN, who made the most extensive travels in the Archipelago of all botanists of past and recent times, has collected near Moeara Enim and Moeara Doea, the plants being described by MIQUEL,

[9] H. PHILLIPPI, Morphologische en geologische aanteekeningen bij de kaart van Zuid Sumatra I. Het Ranaumeer (Jaarverslag Topogr. Dienst Ned. Ind. 12 (1916) p. 182–207, maps).

[10] R. W. VAN BEMMELEN, De undatie theorie (Natuurkundig Tijdschr. Ned. Ind. 92 (1932) p. 85–242: see especially p. 167–211 and fig. 10).

[11] J. VAN TUYN en J. WESTERVELD, Opmerkingen naar aanleiding van de undatietheorie van VAN BEMMELEN en hare toepassing op het westelijk deel van den Soendaboog (Natuurk. Tijdschr. Ned. Ind. 92 (1932) p. 341–372).

[12] See also Encyclopaedie van Nederlandsch Indië, Kroë, 2, p. 451–452.

[13] G. H. NAHUYS, Schets van Bencoolen op de Westkust van het eiland Sumatra (Verhand. Batav. Genootschap, 10 (1825) p. 211–245).

J. W. J. WELLAN en O. L. HELFRICH, Zuid Sumatra I. Overzicht van de literatuur der gewesten Benkoelen, Djambi, de Lampoengsche Districten en Palembang, loopende tot het einde van 1915 (1923); II, idem, loopende van 1916 tot en met 1925 (1928).

J. W. J. WELLAN, Zuid Sumatra, Economisch overzicht van de gewesten Djambi, Palembang, de Lampongsche Districten en Benkoelen. Wageningen 1932.

[14] Flora van Nederlandsch Indië. Eerste bijvoegsel. Sumatra, zijne plantenwereld en hare voortbrengselen, 1860, p. X.

but as far as I know TEYSMANN has never visited the Ranau-region proper.

A long time elapsed before the distinguished British naturalist H. O. FORBES visited the Res. of Benkoelen from August 1883 to January 1884 and made the first collections in the Ranau region.[15] Only a few of his plants have been determined, the bulk having been distributed to various herbaria and not published. Only recently the Staff of the British Museum has given a valuable list of his plants with descriptions of new species.[16] FORBES came from the South to G. Pesagi which he does not seem to have climbed himself; his camp was there at (H)Oedjoeng at about 1000 m alt.; his collectors went up the mountain. He himself went from Oedjoeng via Kenali to Tandjongdjati at the SE. corner of the Ranau and from there to the foot of G. Seminoeng, which he intended to climb, but he fell ill; here also his collectors went up to the higher regions.

In the Herbarium Bogoriense I found some specimens collected on August 28th, 1915, by Dr. P. J. S. CRAMER; this collection, which came from Kenali, is apparently only small.

About the year 1915 or the beginning of 1916 A. J. KOENS made a trip from Kroeï towards the Ranau region of which he gave an account.[17]

L. C. WESTENENK,[18] the well-known former Resident of Sumatra collected some remarkable plants for Buitenzorg and amongst others sent, at the end of the year 1915, a bamboo with massive stems which was planted in the Buitenzorg Botanic Gardens and proved new to science. It was described by C. A. BACKER.[19] It proved to have no great economic value.[20] It was discovered near Ds. Karang, marga Kenali, on the right bank of the river Semangka at about 900 m alt. but seems to occur also in some other places in S. Sumatra, though rare.

C. J. BROOKS, an American engineer, has collected mainly ferns in many islands of the Archipelago and also was in Benkoelen where he collected Phanerogams, too, near Loebok Tandai, a list of which was prepared by Dr. H. N. RIDLEY [12] with descriptions of new species. The last time duplicates were received from his collections at Buitenzorg was in 1923. New Sumatran ferns were described by E. B. COPELAND.[22]

The Forest Service of the Netherlands Indies has collected herbarium material in the Benkoelen Residency since 1922, and a rather important collection has been made in the Ranau region between 600 and 900 m alt., of which Dr. F. H. ENDERT, the well-known explorer of ME. Borneo and stimulator of botanical reconnaissance of the Malaysian forests, has supplied me with a manuscript list.

In the year 1924 Mrs. BOUMAN-HOUTMAN sent a small collection of plants which came from inland Kroeï to the Herbarium Bogoriense; they have been dealt with by Dr. J. G. B. BEUMÉE [23] who also gave an account of earlier collections in Benkoelen. She herself wrote a short article on some orchids.[24]

Recently Dr. J. J. SMITH, our distinguished orchidologist, gave an enumeration of Sumatran orchids in which of course the Orchidaceae of the Ranau region are included.[25]

The "Deutsche Limnologische Sunda-Expedition" was a.o. in Jan.-Febr. 1929 for some weeks on the NW. side of the Ranau. One of the leaders, Prof. F. RUTTNER of Lunz, the well-known limnologist, collected botanical specimens from the vicinity of the Ranau which have been worked up by the author,[26] whilst Prof. RUTTNER himself gave a sketch of the vegetation.[26] The collection is preserved at Buitenzorg, with duplicates in Lunz.

From the year 1928 till April 1933 Mr. C. N. A. DE VOOGD, forester and amateur botanist, made several trips in the Res. of Benkoelen and on these occasions he collected a considerable number of plants including trees as well as herbs and lianas, which have been preserved in the Herbarium, Buitenzorg. He climbed G. Tanggamoes in the extreme South, G. Pesagi (26 Feb. 1928 and April 1933), G. Seminoeng and Bt Pakiwang (accompanied by the author), in the Ranau region, and farther north G. Kaba, Bt Daoen and G. Dempo and in this way made valuable contributions to our knowledge of the series of mountains all over the Benkoelen Residency. He published a popular article on some of his plants,[27] on forest-reserves,[28] on a newly discovered locality of *Rafflesia Arnoldi* R. BR., of the Ranau,[29] on the occurrence of *Mycetanthe Zippelii* (BL.) HOCHR. in Benkoelen [29] and on cultivation experiments with *Shorea platyclados* VAN SLOOTEN in N. Benkoelen [30]. He wrote some short articles on Bt Daoen and G. Kaba, which will be printed shortly in the periodical "De Tropische Natuur."

In the year 1931 Mrs. T. LACH DE BÈRE-VAN DER VLIS gave some notes on South Sumatra.[31]

The last collection in the Ranau region was made by Mr. L. VAN DER PIJL in 1931. He started on the 18th of May from Banding Agoeng at the NW. corner of the Ranau and climbed Bt Pakiwang and from there went towards the W. coast of Sumatra, where he arrived on May 29th. His collection is not very extensive and is preserved in the Buitenzorg Herbarium.

THE AUTHOR's ROUTE AND COLLECTIONS (Oct. 25-Nov. 16, 1929): — The starting

[15] H. O. FORBES, Wanderungen eines Naturforschers im Malayischen Archipel von 1878 bis 1883. 2 vols. Jena 1886 (see I, p. 172-190).

[16] A. B. RENDLE (and others), Dr. H. O. FORBES's Malayan Plants (Journ. Bot. 1924-1926, Suppl. p. 1-149).

[17] A. J. KOENS, Een tochtje in Zuid Sumatra (De Trop. Natuur, 5 (1916) p. 129-134, 167-170, 8 fig.).

[18] L. C. WESTENENK, Memorie van overgave van den aftredenden Resident van Benkoelen (Meded. Encyclop. Bur. afl. 28 (1922) p. 9-11, 83-86).

[19] In K. HEYNE, De nuttige Planten van Ned. Indië, ed. 2, vol. 1 (1927) p. 304. See also C. A. BACKER, Handboek Flora Java, afl. 2 (1928) p. 284.

[20] K. HEYNE, Een massieve bamboe (Teysmannia, 30 (1919) p. 346-347).

[21] H. N. RIDLEY, Plants of Bencoolen, Sumatra (Kew Bull. 1925, p.76-94).

[22] In Philipp. Journ. Sci. 9 (1914) Bot. p. 227-233.

[23] Een paar planten uit Kroeï's Bovenlanden (De Trop. Natuur, 14 (1925) p. 88-93, 3 fig. 1 pl. col.).

[24] Onze bloedvlek-Orchideeën (De Trop. Natuur, 13 (1924) p. 40-43, 2 fig.).

[25] In FEDDE, Repert. 32 (1933) p. 129-386.

[26] C. G. G. J. VAN STEENIS, Die Pteridophyten und Phanerogamen der Deutschen Limnologischen Sunda-Expedition; F. RUTTNER, [illegible] nach [illegible] nungen (Arch. f. [illegible] Suppl. Bd. [illegible] 359-362, Taf. XL [illegible].

[27] C. N. A. DE VOOGD, Botanische aanteekeningen uit de Residentie Benkoelen (De Trop. Natuur, 21 (1932) p. 218-222, 9 fig.).

[28] C. N. A. DE VOOGD, Boschreserveering in de Residentie Benkoelen (Tectona 25 (1932) p. 1598-1612).

[29] In De Trop. Natuur, 21 (1932) p. 211 same, p. 116-117; *22 (1933) 224-229, 9 fig.

[30] In Tectona, 26 (1933) p. 703-713.

[31] Indrukken van Zuid Sumatra (Trop. Nederland, 6 (1931-'32) p. 32 seq., p. 35 seq. ill.).

point was Kroeï where in the vicinity of the harbour 56 nos were collected, especially of the Barringtonia-formation, Algae and ruderal plants. The elevated coral reefs bear a vegetation of small, crooked *Pandanus*, *Scaevola frutescens* KRAUSE, *Ardisia humilis* VAHL, *Crinum asiaticum* L. and groups of *Cycas Rumphii* MIQ. Some plants of importance were collected here, as *e.g. Aphania* sp. (3137), *Parsonsia* sp. (3138) and a *Mucuna* (3139) which I cannot distinguish from *M. acuminata* GRAH. found in Java chiefly at medium altitudes. This phenomenon will be discussed later in this paper.

A peculiar distribution is shown by *Timonius compressicaulis* BOERL. VALETON remarks that this species, which is only found in forests on or near the seashore, should occur also in the Marshall Islands.

From Kroeï, which we left by car, a most beautiful mountain road leads across the Barisan mountain chain with fine views on the roughly eroded landscape with deep gullies and forest-clad peaks and ridges. Up the steep, rocky or clayish slopes we observed some typical representatives of kremnophytes: *Gleichenia*, *Pogonatherum paniceum* HACK., *Arundina*, *Rhododendron ?javanicum* BENN., *Saccharum spontaneum* L. and others. The Liwa plateau is mostly deforested. Near Tandjongdjati we approached the Ranau and climbed a very steep, new road ca 9 km long to the tea-plantation Goenoeng Raja at ca 1000 m alt. where we made the acquaintance of the late Mr. S. LEDEBOER. With him we planned the route for some excursions and after having refreshed ourselves went down the same way and along the northern border of the Ranau to Banding Agoeng where a former manager's house of the Syndicate was our headquarters for the next 3 weeks. From there excursions of one day or more were made around the Ranau, the thickets between the Koeala and Bt Pakiwang, to Sepatoehoe, Bt Pakiwang, G. Raja, G. Pesagi, Air Telanai and the northern side of the foot of G. Seminoeng, where on account of an accident the author had while cutting a path, he had to return and could not reach the mountain forest. In all some 900 herbarium numbers (some with wood-samples) were secured. In the following pages I have tried to give some floristical and physiognomical notes on the localities visited.

## SKETCHES OF THE VEGETATION: —

**The vegetation of the Ranau.** Along the NW. side of the Ranau there is a beach where a rather heavy surf has built up a narrow strip of drift consisting of waterplants, mainly of *Ceratophyllum demersum* L., *Najas falciculata* A. BR., *Potamogeton pectinatus* L. and *Hydrilla verticillata* ROYLE. On the shallow sandy bottom in this corner before the swimming-place *Potamogeton pectinatus* L. forms a rather dense submerged vegetation on the sandy bottom in the clear water 30-100 cm deep. A peculiarity in deeper water, about 100 m distance from the beach, is a tree resembling a pollarded willow in water ca 2-2½ m deep of which the pollard just emerges above the surface. It is densely covered by ferns and some grasses and roots at the bottom. In what manner it has arrived there is rather a problem. I have observed also in other localities such isolated trees in the Ranau not very far from the shore. The same is mentioned by RUTTNER from Lake Singkarak[32] in M. Sumatra. It is ascribed there to land-slides from the shore caused by earthquakes in the year 1926. Recently Dr. H. R. A. MULLER observed several of these isolated trees in the Ranau near Kota Batoe in the E. corner of the lake, which was due to the depression of this part of the shore by the heavy earthquakes in 1933: this rice-field area is now inundated for several meters.

**The flora of the sandy beach** consists of some Cyperaceae, *Pouzolzia zeylanica* BENN., a non-thorny form of *Amarantus spinosus* L. and some creeping plants, *viz. Cucumis Melo* L., *Enhydra fluctuans* LOUR., *Lycopersicum esculentum* MILL. and *Alternanthera sessilis* R. BR. Behind the beach there is a narrow strip of trees and bushes of which may be mentioned: *Homalanthus populneus* O.K., *Erythrina fusca* LOUR., *Kleinhovia hospita* L., *Pipturus repandus* WEDD., *Hibiscus tiliaceus* L., *Clerodendron serratum* SPR., *Melastoma malabathricum* L., *Flueggea virosa* BAILL. infested with the parasites *Scurrula fusca* G. DON., *Dendrophthoe pentandra* MIQ., *Macrosolen cochinchinensis* V. T. and *Viscum articulatum* BURM., the latter not as is usually the case hyperparasitic on the other Loranthaceae but directly on the *Flueggea* (see De Trop. Natuur, 19 (1930) p. 103), *Eugenia densiflora* DUTHIE and *E. polyantha* WIGHT, *Saccharum spontaneum* L., several species of *Ficus*, o.a. *Ficus retusa* L., *Clerodendron fragrans* WILLD., *Trigonostemon* (3506), *Bischoffia javanica* BL., *Mallotus floribundus* M. A., *M. repandus* M. A. and *Vitex trifolia* L. Climbing and rambling are *Wedelia montana* BOERL., *Dioscorea hispida* DENNST., *Hiptage Madablota* GAERTN., *Millettia sericea* W. & A., *Elaeagnus latifolius* L., *Beaumontia grandiflora* WALL., *Conocephalus suaveolens* BL., *Hoya* (3473), *Panicum sarmentosum* ROXB., *Pycnarrhena cauliflora* DIELS, a large *Canavalia* (3306) and *Trichosanthes bracteata* VOIGT.

Of these, three plants deserve special attention, as their occurrence is usually near the sea, *viz. Hibiscus tiliaceus* L., *Vitex trifolia* L. and *Pongamia pinnata* MERR. I believe all three of them are or were cultivated here.

Where the coast is rocky and steep and the sandy beach is absent the forest border extends to the surf. The outer trees are bent over the water and it often occurs that some of them are washed down. The hilly country around the lake was originally covered with dense forest, but at least on the northern side of the Ranau this is but rarely spared. In the flat places there are paddy-fields and otherwise there is thicket and secondary growth.

The **rice-fields,** s a w a h s, bear a different flora in the different stages of inundation with crop, and non-inundated fallowland, which is the so-called double-flora. In the fallow sawahs characteristic plants are *Hyptis brevipes* POIR., *Erechthites hieracifolia* RAFIN., *Asclepias curassavica* L., *Dysophylla Auricularia* BTH. and *Panicum lutescens* WEIG. var. *flava* BACKER. Each of these may occur in unlimited quantities. In the inundated planted sawahs the most abundantly occurring species are *Fuirena umbellata* ROTTB., *Scoparia dulcis* L., *Hypericum mutilum* L., *Hyptis brevipes* POIR., *Kyllinga melanosperma* NEES and *K. brevifolia* ROTTB.,

[32] F. RUTTNER, Hydrographische und Hydrochemische Beobachtungen auf Java, Sumatra und Bali (Arch. f. Hydrobiol. Suppl. Bd. 8 (1931) p. 345–346; see also in the same volume pl. IV).

*Lipocarpha argentea* R. BR., *Eleocharis variegata* KTH., *Cyperus pilosus* VAHL, *C. odoratus* L., *C. Haspan* L., *Fimbristylis miliacea* VAHL, *Scirpus mucronatus* L., *Rhynchospora corymbosa* BRITT., *Scirpus grossus* L. and *S. erectus* POIR., *Hymenachne indica* BUESE, further *Jussieua repens* L., *J. linifolia* VAHL, *Monochoria hastata* SOLMS (here more common than *M. vaginalis* PR., whereas in Java the reverse is the case!), *Lindernia cordifolia* MERR., *Ilysanthes antipoda* MERR., *Oldenlandia diffusa* ROXB. and *Ceratopteris thalictroides* BRONGN.

Between the sawahs small streamlets wind towards the Ranau and here and there small, stagnant pools are found with waterplants such as: *Ottelia alismoides* PERS., *Hydrilla verticillata* ROYLE, *Najas falciculata* A. BR., *Limnophila indica* DRUCE, *Lophotocarpus guyanensis* SMITH, *Azolla pinnata* R. BR., *Lemna paucicostata* HEGELM., *Salvinia natans* L., *Pistia Stratiotes* L., *Limnanthemum indicum* THW. I did not succeed in rediscovering *Limnanthemum sumatranum* S. MOORE near Oedjoeng, which was collected there by FORBES some 50 years ago. Also *Blyxa* was not secured, but Mr. DE VOOGD later found it near Moeara Doea (*cf.* De Trop. Natuur XIX, 1930, 105).

The vegetation of the **hot springs Wai Panas** near the Ranau at the N. foot of G. Seminoeng I did not visit; RUTTNER collected there f.i. *Ficus retusa* L., a typical tree of forest-swamps and *Ficus diversifolia* BL., a typical crater- and solfatara-plant.

Behind the sawahs most of the vegetation consists of thickets and higher secondary growth, some groves of *Ficus elastica* and a r è n and coffee plantations. Only near Sepatoehoe long strips of primary forest were at that time untouched, but it was planned that these also should fall under the axe, except that of the narrow gullies and along the steep slopes of the ridges.

In the **secondary growth** there are some peculiar physiognomical features which are deserving of attention and description. As I have said, a l a n g-fields (*Imperata*) play a very unimportant role in this region. The principal plant of the thickets is *Lantana Camara* L. which covers wide areas on the N. slope of G. Seminoeng and E. of the G. Raja plantation to the foot of G. Pesagi and is accompanied by very few other plants. Where in other localities the thicket is of mixed character the following species occur frequently: *Dillenia* (3175), *Colona javanica* BURR. (k a j o e b a r o e (Makakau), h a l i a n j a n (Ranau) of which the white bark is used for pleating-work), *Macaranga Tanarius* M. A., *Debregeasia longifolia* WEDD., *Villebrunea rubescens* BL., *Saurauia* sp., *Allophylus Cobbe* BL., *Leea* sspp., *Callicarpa pentandra* ROXB. and *C. longifolia* LAMK., *Mussaenda frondosa* L., *Commersonia Bartramia* MERR., *Homalanthus populneus* O. K., *Mallotus acuminatus* M. A. and *M. ricinoides* M. A. & *Lagerstroemia speciosa* PERS. Climbers are such as *Polygonum chinense* L., *Rubia cordifolia* L., *Uvaria purpurea* BL., *Mikania scandens* WILLD. and various Cucurbitaceae such as: *Thladiantha cordifolia* COGN. and *Momordica subangulata* BL. It would take far too long to give an account of the various herbs of which I only will mention *Donax canniformis* K. SCH. on which I found only once instead of fruits peculiarly developed club-shaped organs which are caused by a rare fungus: *Epichloe Warburgianum* (det. by Dr. K. B. BOEDIJN).

A very instructive secondary forest was met with at the foot of G. Pesagi which showed in a most embarrassingly regular way the development of a 2-layered vegetation. The lower layer was formed by a dense thicket of *Lantana Camara* L. only ca 2–3 m high and the upper layer was formed by rather lax forest of white trees ca 10 m tall, all of the same age, called a n g g r o e n g by my native companions (mainly Javanese) — *Macaranga ?bancana* MIQ.[33] (3652). On my various trips in the tropics I never have seen any such fine example of a naturally grown secondary vegetation which was so regular in appearance; the trees seemed almost planted. I assume it to be a temporary stage towards more advanced secondary growth, as both species are practically absent in the surrounding closed taller secondary forest. During the succession towards tall, closed forest the plants which need full light (as *Imperata*, *Lantana* and other b l o e k a r plants) gradually disappear.

Mention must be made of the peculiar occurrence of *Usnea barbata* which occurs abundantly on some isolated trees at an altitude of about 450–550 m, but is absent from the closed vegetation. I found it on some specimens of *Toona Sureni* MERR., on a few trees of *Parkia* and *Tamarindus* near the Ranau and on one small *Citrus* tree near Air Telanai, all planted species. I do not suspect it to be a relic of formerly closed vegetation as generally *Usnea* occurs abundantly at much higher altitude. It must be remarked that the trees stood isolated (see De Trop. Natuur XIX, 1930, p. 141-142).

**The primary forest between 500 and 1000 m altitude.** This consists of tall trees among which are many dipterocarps such as *Shorea* (3818) and *Dipterocarpus Hasseltii* BL., further *Paranephelium xestophyllum* MIQ., *Gordonia excelsa* BL., *Artocarpus* sp. (3378), *A. elastica* REINW., *Laplacea ?subintegerrima* MIQ., *Mangifera macrocarpa* BL., *Kibessia azurea* BL., *Stelechocarpus Burahol* HOOK. F. & TH., a *Canarium* with lemon-scented resin (3213) of the already cut trunk of which I could only collect a wood-sample and some resin, *Neesia piluliféra* BECC. and *N. altissima* BL., *Podocarpus neriifolia* BL. and *P. Blumei* PILG.,[34] *Diospyros aurea* T. & B., *Pyrenaria serrata* BL., *Machilus* (3408), *Cinnamomum iners* REINW., *Pometia pinnata* FORST., *Voacanga foetida* ROLFE, *Radermachera gigantea* MIQ., *Ficus* sspp. (a.o. *Ficus lepicarpa* BL.), *Taraktogenos heterophylla* VAN SLOOTEN, *Dysoxylum* sp., *Aglaia* sp. to which Dr. ENDERT added from the collections by the Forest Service *Acronychia laurifolia* BL., *Pterospermum* sp., *Palaquium* sp., *Ternstroemia* sp., *Santiria oblongifolia* BL. and *S. rubiginosa* BL., *Platea* sp., *Macaranga hypoleuca* M. A. and *M. Diepenhorstii* M. A., *Cassia siamea* LAMK., *Payena* sp., *Calophyllum* sp., *Dipterocarpus gracilis* BL., *Alangium* sp., *Endospermum* sp., *Garcinia* sp., *Terminalia* sp., *Ryparosa*

[33] Possibly only a form of *M. triloba* M.A.

[34] It is perhaps not generally known that the allies of *P. Blumei* which in sterile state much resemble the genus *Agathis* can at once be distinguished from it by the acute buds which in *Agathis* have a broadly rounded top. I believe Dr. F. H. ENDERT was the first who observed this and mentioned it in the Meded. Boschproefstation Boschwezen N.I. 20 (1928) p. 108. This most valuable book contains many original clues for identification of sterile material of Netherlands Indian trees and I can strongly recommend it to the attention of all botanists working on taxonomy and general morphology. It is to be regretted that it has been written in Dutch and thus is known in too narrow circles only.

*caesia* BL., *Cyathocalyx* sp., *Michelia* sp., *Evodia* sp., *Gynotroches*, *Castanea*, *Shorea platyclados* VAN SLOOTEN and *S. leprosula* MIQ., *Xylopia malayana* HOOK. F., *Engelhardtia* sp., *Amoora* sp., *Ctenolophon* sp., *Dyera costulata* HOOK. F., *Koompassia malaccensis* MAING., *Baccaurea* sp., *Nyssa javanica* WANG., *Rhynchocarpa monophylla* BACKER, *Sandoricum* sp., *Adina polycephala* BTH., *Drypetes* sp., *Casearia esculenta* VAN SLOOTEN, *Phoebe* and *Notophoebe*, *Sapium baccatum* ROXB., *Adinandra* sp. and *Schima bancana* MIQ. Some of the trees of the humid primary high-stemmed forest are deciduous as *e.g. Gossampinus Valetonii* BAKH., *Pterocymbium javanicum* R. BR. and *Peronema canescens* JACK, the latter occurring mostly in thickets and only very rarely seen (near Sepatoehoe) on a ridge in primary forest. The poeloes or loeloes, *Tristania Wightiana* GRIFF., conspicuous by its very tall stem, which always is more or less twisted as are the main branches, and is white and entirely smooth with the bark fallen off, deserves special attention. I found it only near ridges and especially against steep slopes, rarely singly, mostly in groups of 3–10, both on Bt Pakiwang and the ridges between the so-called d j o e r a n g s in Sepatoehoe.[35] Dr. ENDERT told me that also in ME. Borneo he found *Tristania* sspp. mostly on ridges and steep slopes. The topography of the Sepatoehoe plateau is very remarkable. It consists of broad rather flat ridges and spurs supposed to have originated by former l a h a r s, *i.e.*, ejections of volcanic material, mainly tuff. The latter are separated by deep ravines, the above mentioned d j o e r a n g s, with very steep walls. The bottom of these gullies is rather dry and consists mainly of quartz sand (mixed with glittering particles of muscovite) where some herbs are common: *Dichroa febrifuga* LOUR., *Stenosemia aurita* PR., *Globba* sp. (3210), *Cyrtandra glabra* JACK and *C. pendula* BL., *Elatostema*, *Microcos florida* BURR., *Ficus* sspp. (3206, 3223) and *Laportea stimulans* MIQ. here flowering already as a shrub ca 50 cm tall. As can be seen from the map of the Ranau region, the ridges end abruptly in the N. of the Sepatoehoe plateau, and there we had a fine view over extensive primary forest towards the North. Along the steep slopes of the d j o e r a n g s the trees are locally wholly covered and coloured by a beautiful and gigantic, scarlet-flowered *Bauhinia* (3407) and by *Millettia* (3382).

In the forest along the road from Banding Agoeng towards Simpang and from there towards Moeara Doea a large, abundant, red-flowered *Durio* (3861) with smaller fruits than in the whitish flowered *D. zibethinus* was quite conspicuous; Mr. BAKHUIZEN VAN DEN BRINK thinks this undoubtedly native plant represents a new species *D. spontaneus* BAKH. ms.

Amongst the smaller trees and shrubs are numerous species of *Ficus*, f.i. *F. rostrata* LAMK., *F. Ribes* BL., many species of *Ardisia* (f.i. *A. vestita* WALL.) and of *Saurauia* and some of *Mitrephora* (f.i. *M. obtusa* MIQ.). Rattan is scarce except on the eastern slopes of G. Pesagi; *Areca* (3425) is rather common. Of the Annonaceae must be mentioned *Orophea* (3504) and *O. hexandra* BL. whilst on the slopes of Bt Pakiwang I collected a *Goniothalamus* with a peculiar stiff habit, very angular stems and a fragrant bark. Very common are the Rubiaceae such as *Saprosma fruticosum* BL., *Chasalia*, *Ixora nigricans* BL., *I. javanica* DC. and *I. grandiflora* VAL., many species of *Lasianthus*, and many Euphorbiaceae (*Galearia filiformis* BOERL., *Sauropus spectabilis* MIQ. with beautiful large red fruits, *Claoxylon longifolium* MIQ. with velvety fruits and red-orange arillus and *Antidesma leucopodum* MIQ.). Further there are the Sapindaceae (*Heynea fruticosa* T. & B., *Lepisanthes montana* BL., *Turpinia montana* KOORD.), 3 Flacourtiaceae (*Osmelia grandistipulata* VAN SLOOTEN, *Hemiscolopia trimera* VAN SLOOTEN, formerly only known from Banka, W. Java, and *Bennettia leprosipes* KOORD.), 2 Ebenaceae (*Diospyros subrhomboidea* K. & G. and *D. buxifolia* HIERN), further representatives of other familise: *Talauma Candollei* BL., *Phaleria capitata* JACSK, *Dalbergi pinnata* PRAIN, *Linociera montana* DC., *Murraya paniculata* THUNB., *Knema glauca* WARB., *Ouratea sumatrana* GILG.

The number of *climbers* is rather large; amongst them are many species of *Tetrastigma* and *Piper*, several Cucurbitaceae (*Hodgsonia macrocarpa* COGN. a very large species, and *Macrozanonia macrocarpa* COGN.) thoughmost of the Cucurbitaceae prefer the secondary growth, several species of *Bauhinia*, Olacaceae (*Erythropalum scandens* BL. and *Phytocrene macrophylla* BL.), Menispermaceae (*Stephania capitata* SPR. and *Haematocarpus comptus* MIERS) though also more numerous in the thickets, Annonaceae (*Melodorum Kentii* HOOK. F. & TH. and a fine *Artabotrys cf. Blumei* (3449) which formed large garlands and bowers). On the northern slope of Bt Pakiwang I collected a species of *Aristolochia* (3767) unfortunately sterile, but probably new, with very densely hairy leaves and differing from *A. coadunata* BACKER. Near the same locality there was a very robust *Gnetum* (3456) with large olive-brown fruits. *Kadsura scandens* BL. is common, *Zizyphus inermis* MERR. rare (hitherto known from the East coast of Sumatra, Borneo, Celebes and the Philippines).

Among the *herbs* there are many Rubiaceae (*Lerchea interrupta* MIQ., *L. bracteata* VAL., *L. longicauda* L., *Coptophyllum pilosum* MIQ., *Argostemma borragineum* BL., *Acranthera mutica* VAL., numerous species of *Ophiorrhiza*, *Spiradiclis caespitosa* BL., *Xanthophytum fruticulosum* REINW., *Geophila melanocarpa* RIDL.) and numerous Acanthaceae of which may be mentioned *Acanthopale* (3422), several Urticaceae, especially *Elatostema* which sometimes forms the principal element in the weed-flora of dark jungle and *Pellionia* (3392) locally filling up shallow pools. Also *Lycianthes* is common as is *Susum malayanum* HOOK. F. with its red petioles and underside of the leaves. The same habitat — tall rather dark jungle — is preferred by many Araceae, *Labisia pumila* BTH. & HOOK. F., *Ophiopogon caulescens* BACKER, *Peliosanthes javanica* HASSK., *Disporum chinense* DON, *Desmodium laxum* DC. and *D. Scalpe* DC. Some herbs appear always gregarious as *Forrestia* and *Aneilema conspicuum* KTH. on rather dry soil and *Lobelia succulenta* BL. in pools made by elephants. *Coleus* (3386) forms patches on muddy soil, others occur scattered as *Gomphostemma*, *Paraphlomis*, *Curculigo capitulata* O. K., *Nervilia Aragoana* GAUD., *Polygala venenosa* HASSK., *Calanthe veratrifolia* R. BR., *Acanthephippium pauciflorum* HASSK. (hitherto only known from

[35] *Tristania* shows the same architectural tree habit as some other Myrtaceae, such as *Eucalyptus* and full-grown tall specimens of *Leptospermum flavescens*; this is possibly an ancient phylogenetical characteristic.

Java), some grasses as *Leptaspis urceolata* R. BR. and *Panicum uncinatum* RADDI, *Didymocarpus barbata* R. BR., *Carex breviscapa* CLARKE (= *Curtisii* RIDL.), *C. cryptostachys* BRONGN., *Mapania* (3778), *Begonia isoptera* BL. and *Sanicula europaea* L. Some Zingiberaceae live gregariously as *Phrynium*, *Achasma* (3411), *Phaeomeria* (3787). Numerous ferns occur of which only the rare *Asplenium obscurum* BL. can be mentioned, which occurs always near streams in very wet places, formerly known only from W. Java. Some herbs which propagate themselves by long stolons and form pure patches in this way deserve special attention: *Pollia Aclisia* HASSK., *Desmodium trifoliastrum* MIQ. and *Rungia coerulea* WARB. Only one leaf was observed of the gigantic *Amorphophallus Titanum* BECC.; it measured ca 4½ m in length, the soft, porous, chambered petiole attaining ca 30 cm in diameter. Other herbs belonging to the kremnophytes are characterised by a poorly developed root system and a juicy stem; they occur mostly against wet rocks. To these belong *Rhynchoglossum obliquum* HAM., *Monophyllaea Horsfieldii* R. BR., *Peperomia laevifolia* BL., *Zippelia begoniifolia* BL., *Epithema* sspp., *Stauranthera coerulea* MERR. and *Elatostema* cf. *paludosum*, the permanent companion of waterfalls in Java.

Several *saprophytic herbs* have been found in the Ranau region: *Epirrhizanthes papuana* J. J. S., *Burmannia candida* BL., *Cotylanthera tenuis* BL., *Cystorchis aphylla* RIDL. and *Stereosandra*.

*Epiphytes* are rather common, especially ferns: *Drynaria rigidula* BEDD. forms large nests round the branches, as does *Polypodium punctatum* Sw., *Davallia denticulata* METT. creeps, *Medinilla* is a shrub. Hymenophyllaceae are conspicuously poorly represented at this altitude.

*Parasitic* shrubs are *Elytranthe albida* BL. on oak; of *Loxanthera speciosa* BL. and *Lepeostegeres Beccarii* GAMBLE only fallen flowers could be collected.

**The gorge of Air Telanai** N.W. of the Ranau, which I followed for some miles, has very steep slopes which are mostly forested, f.i. with numerous bamboos (*Schizostachyum*, 3495), Marantaceae and *Musa*. The *Musa* (3950) was certainly wild but I failed to identify it. Against almost perpendicular earth-walls the common kremnophytous vegetation is developed (*Antrophyum reticulatum* KAULF., *Ceropteris calomelanos* UND., *Odontosoria chinensis* J. SM., *Onychium siliculosum* C. CHR., *Gleichenia* and *Pogonatherum paniceum* HACK.). Against the perpendicular rockwalls of the gorge Araceae, Urticaceae and ferns have settled themselves in the clefts and cracks.

**The mountain forest of Bt Pakiwang** (1631 m alt.). This mountain is easy to climb from Banding Agoeng. Its northern foothills, which are surrounded by a stream, are cultivated but after that the jungle of its slopes can be entered after passing rapids of another stream. A path cut by the Forest Service leads to about 1000 m alt. after which elephant-trails are followed towards the crest. Below, the slope is rather steep and sandy but higher up it becomes clayish and muddy. *Scutellaria javanica* JUNGH. var. *sumatrana* BACKER is rather common and has blue flowers on the lower slopes but white ones higher up. The forest is tall and contains numerous oaks, *Castanea* and *Altingia Noronhae* (here called t j e m o r o in the Makakau dialect). From ca 1300 to 1500 m the ground slopes gently upwards, the forest floor being covered with a dense monotonous undergrowth of *Strobilanthes* sp. At about 1500 m alt. the character of the forest changes, the height of the trees diminishes to ca 5–10 m, the stems are thin, very mossy and partly crooked. This mossy forest covers the top region and no view over the surrounding country is possible even on the highest point near the fallen survey post. In this shrubby thin-stemmed, densely moss-covered thicket I collected *Evodia accedens* BL. (common), *Breynia microphylla* M. A., *Litsea diversifolia* BL., *Matthaea latifolia* PERK. (3902), *Ardisia* (3882), *Polygala pulchra* HASSK., *Ixora grandifolia* Z. & M. (3907) and others. On the stems numerous Hymenophyllaceae occur (f.i. *Hymenophyllum salakense* RACIB. formerly only known from Java & *H. australe* WILLD.), many ferns (*Hymenolepis revoluta* BL., *Polypodium mollicomum* NEES & BL., *P. contiguum* J. SM., *P. obliquatum* BL., *P. congener* PR., *P. Mettenianum* CES.), orchids (*Dendrochilum rigidulum* J. J. S., *Bulbophyllum dempoense* J. J. S.) and a *Hydnophytum*. The herb-flora is embedded in the moss-cushions between the roots, buttresses and air-roots of the trees; among it are fine-coloured plants but it is rather scarce; *Sanicula europaea* L. is common, *Calanthe flava* HASSK. and *Impatiens* (3897) have yellow flowers, *Coelogyne Steenisii* J. J. S. n.sp. salmon-coloured flowers, *Argostemma montanum* BL. and *A. parvifolium* BENN. have white flowers, *Pratia nummularia* BL. purple berries, *Lycianthes* (3895) purple flowers, *Coleus galeatus* BTH., *Sonerila tenuifolia* BL. blue ones and *Arisaema* (3879) somewhat dirty-green ones. None of the yellow-flowered species of *Impatiens* has ever been found in Java, though several species are known from Sumatra even to the extreme South on G. Tanggamoes. The same is the case with *Anemone sumatrana* DE VR. In Tjibodas Dr. W. M. DOCTERS VAN LEEUWEN has planted Sumatran species of both genera in the mountain forest above Tjibodas where they thrive pretty well. So the climate or soil can give no clue as to their absence in Java.

**The mountain forest of G. Raja** (1643 m alt.). The ascent from the G. Raja tea plantation up this mountain is very simple, if once the right trail through the secondary growth towards the West is found. At first there is tall forest of *Quercus*, *Castanea*, *Engelhardtia*, *Podocarpus*, *Weinmannia Blumei* PLANCH., *Styrax paralleloneurus* PERK., *Litsea*, *Gynotroches axillaris* BL., *Memecylon*, *Ryparosa caesia* BL. and other trees. Though the quantity of moss increases as one ascends, the forest remains rather tall until one reaches the ridge which slowly leads up to the crest. This ridge is covered with a dense thicket of shrubby trees though rather high trees are not absent on the other spurs and the W. slope especially. Just below the ridge we had already observed *Balanophora elongata* BL., *Sonerila tenuifolia* BL., *Argostemma parvifolium* BENN. of which the conspicuous flowers are white save for the bright-yellow free part of the filaments, the quite white-flowered *A. montanum* BL., *Nertera depressa* BANKS & SOL., *Pratia nummularia* KURZ, *P. montana* HASSK. and *Burmannia disticha* L. On the ridge dense thickets are

formed by *Allaeophania rugosa* HOOK. F. and especially *Oleandra neriiformis* CAV. In the open space cut round the survey pillar *Gleichenia laevigata* HOOK. forms dense masses with *Rubus moluccanus* L., *Polygonum chinense* L., *P. malaicum* DANS. and *Torenia asiatica* LOUR. The eastern slope of the crest ridge is very steep and there a large part of the vegetation is formed by *Dipteris conjugata* REINW. and *Oleandra neriifolia* CAV. In the thicket on the ridgė the following trees and shrubs were collected: *Glochidion* (3520), *Ardisia* (3513), *A. vestita* WALL., *A. linearifolia* MIQ., *Maesa* (3519), *Aphanomyrtus* (3518), *Litsea*, *Urophyllum* (3589), *Quercus* and others. In the moss cushions many epiphytes, especially ferns (Hymenophyllaceae, *Polypodium costulatum* BAKER, known from Sumatra, Borneo and New Guinea, *P. rupestris* BL.) and Orchidaceae (*Ceratostylis leucantha* SCHLTR., *Bulbophyllum parvilabium* SCHLTR., *B. proximum* J. J. S., *B. appressicaule* RIDL.) are more or less embedded. Also *Medinilla* sp. (3525) and *M. laurifolia* BL. are found there and some climbers (*Dischidia*, 3555) and a few *Nepenthes* (3530).

**Trip to G. Pesagi** (2175 and 2232 m alt.). This mountain, which is much richer in flora than the foregoing two, can be climbed from two sides. FORBES and later DE VOOGD came from Oedjoeng; this is by far the easiest way, and then I believe the trip takes only one day. I came from the G. Raja tea plantation at the E. foot of G. Raja with 16 men. The trail up to the base of the mountain had previously been found by their leader and led for about 10 hours up and down through thickets and secondary forest in a SE. direction up to an altitude of about 1000 m where we camped that day. There the sloping mixed forest begins and after some hours ascending along an elephant-trail leads to a rather steep, very humid, mossy and stony ridge, with a rather lax forest, but with tall trees of *Quercus*, *Castanea*, *Podocarpus imbricata* BL., *Engelhardtia*, *Styrax paralleloneurus* PERK. and others. In the undergrowth I found many young specimens of *Bucklandia populnea* R. BR. (= *tricuspis* HALL. F.). At about 1800 m the quantity of moss on the trees and on the ridge itself increased. In the former *Selaginella involvens* HIERON. and *Mniodendron* are conspicuous; here also was a good locality for *Treubia insignis* GOEB.[36]

Fine-flowered herbs enliven the often misty forest: *Nertera depressa* BANKS & SOL., *Pratia nummularia* KURZ, *Lycopodium serratum* THUNB., *Burmannia disticha* L., *Ophiopogon caulescens* BAKER, *Ardisia vestita* WALL., *Disporum chinense* DON (= *pullum* SALISB.), *Carex leucostachys* RIDL. (here recorded for the first time for Netherlands India, formerly only known from the Malay Peninsula), *Psychotria*, *Impatiens*, *Argostemma* sp. (3708) and *A. parvifolium* BENN., *Platanthera angustata* BL., [illegible] BL., the epiphytic *Dendrobium Hasseltii* LINDL. and the parasitic *Helixanthera carinata* DANS. Higher up the trees gradually decrease in size and at about 1800 m alt. the mossy forest is only ca 10 m tall. There I found the first specimens of the typical *Ainsliaea pteropoda* DC., an extremely lank Composite, and in the same locality the only Netherlands Indian *Anemone*, *viz. A. sumatrana* DE VR. I have found these two only up o the northern top of the mountain. From this top a narrow ridge leads to the southern highest one which bears only a shrubby vegetation about 1–2 m tall with abundant *Dipteris conjugata* and *Oleandra neriiformis* Cav. and a dense thicket in which many *Ericaceae* (*Vaccinium ellipticum* MIQ. and sp. (3692) not identical with *V. besagiense* S. MOORE described from here, *Rhododendron javanicum* BENN., *Diplycosia heterophylla* BL., *Gaultheria fragrantissima* WALL. with the parasitic *Macrosolen avenis* DANS.), further *Rapanea* (3750), *Symplocos Nageli* K. & V., a small tree with red petioles and midrib and pearl-grey fragrant flowers, *Lindera bibracteata* BOERL., *Melastoma*, *Viburnum coriaceum* BL., *Ficus diversifolia* BL., *Evodia* (3624), *Weinmannia Blumei* PLANCH., *Leptospermum flavescens* SM., *Rubus lineatus* REINW., *Podocarpus neriifolia* BL., *Lycopodium cernuum* L. var. *salakense* V. A. V. R., *Ardisia* sp. (3608, 3610) and *A. javanica* DC. More rare are *Nepenthes pectinata* DANS. and *N. singalana* DANS. From a tree at the margin of the forest garlands of *Lycopodium casuarinoides* SPR. stream down. Here and there climbs the slender *Crawfurdia trinervis* DIETR. and *Alyxia* (3684). The southern top at 2232 m altitude is a small plateau with a survey pillar in the centre. The thicket on the plateau has been mostly cut down and in this open place we found *Isachne albens* TRIN., a violet out of flower, and *Carex* (3684, 3701). The thicket on the surrounding slopes leading to several ridges is rich in epiphytes, especially ferns (*Polypodium contiguum* J. SM., *P. tenuisectum* BL., *P. incurvatum* BL., *P. Curtisii* BAKER, *Hymenophyllum* aff. *denticulatum* SW., *H. Neesii* HOOK., *Vittaria lloydiifolia* RACIB., *Campium heteroclitum* COPEL.), Ericaceae (*Rhododendron malayanum* JACK & *Vaccinium lucidum* MIQ.), *Ficus diversifolia* BL., and many orchids (*Ceratostylis*, *Liparis arcuata* J. J. S., *Dendrobium pedicellatum* J. J. S., *Eria Rhinoceros* RIDL., *Dendrochilum*, *longebracteatum* PFITZ., and a large species (3706)). On all sides the ridges are very steep and, as I was through with collecting at noon, I decided to try the southern ridge. That one ends, however, after an hour's walk, in a precipice several hundred metres deep wholly covered with *Dipteris conjugata* REINW. and cannot be descended. We returned to the top where camp was made. The following morning the trail was found by sending on ahead a few men without loads, who signalled back when they had discovered it. In general it is much easier to find a trail when climbing than when descending. From the top one must go about 50 or 100 meters S.SE., then turn abruptly to the left and leaving what is apparently the right ridge, after which the southeastern spur will be reached, which, turning gradually towards the east, leads in the right direction for Oedjoeng. Descending this ridge there is a deep gully on the right with a stream at the bottom. At about 1800 m the elephant-trails appear again and there are traces of cutting from men in search of rattan. This is very abundant in these lower forests. In descending we lost the right trail. I kept straight E. on the compass and at last waded through the above mentioned stream which runs through a narrow gorge. In the afternoon at about 5 o'clock we reached the first ladang near Oedjoeng and walked from there to Kenali where the party arrived at about eleven in the evening. In the gorge I found a fine yellow species of *Impatiens* and a large-flowered, white, 4-merous Rubiaceous herb from the rocks (3739).

[36] C. G. G. J. VAN STEENIS, Treubia insignis in Sumatra gevonden (De Trop. Natuur, p. 213–215, 3 fig.).

# HISTORY OF RUBBER CULTIVATION AND RESEARCH IN THE NETHERLANDS INDIES

*by*

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Although it is one of the youngest of the great planting industries in the Netherlands East Indies, the cultivation of rubber has developed more rapidly and spread more extensively than the others. Today, millions of the islands' population are wholly or partly dependent upon the production of rubber for their livelihood.

Although some rubber planting had been done before 1900, it was not until the first decade of this century that the new industry was definitely established in the East Indies.

In those early days the pioneers had to choose between several kinds of rubber-producing trees of which very little was known about either their yielding capacity or their requirements for cultivating. One rubber tree, *Ficus elastica*, grows wild in the forests of Java and Sumatra. As early as 1864, a small plantation of this tree was put in the ground in West Java; it still exists, and is known as "the world's oldest rubber plantation." The other rubber-yielding trees were *Castilloa elastica*, *Manihot Glaziovii*, and *Hevea brasiliensis*, all natives of South and Central America, and *Funtumia elastica*, a West African plant. With the exception of the last, all these were planted on a small scale in various places of Java in the years between 1870 and 1890.

The extension of rubber cultivation in the East Indies was the outcome of a combination of many factors. After 1898, coffee, grown on estates in Java and Sumatra, had suffered badly from the low prices that resulted from the tremendous expansion of its cultivation in Brazil. On the East Coast of Sumatra the flourishing tobacco cultivation had extended beyond soils suitable for this plant; the returns there were hardly profitable. The demand for rubber from tire manufactures was growing steadily, and it was obvious that the supply of rubber collected from trees in the wilds of the tropics could not meet the demand. As a consequence, the price of rubber went up; in the boom years of 1910 to 1912 it reached the price of more than $3.00 per pound. No wonder that owners of estates with unprofitable crops turned to rubber! No wonder that the money market responded favorably to the demand for capital to invest in rubber plantations!

In this period of sudden expansion, the planters, most of whom were unacquainted with rubber cultivation, turned to the Department of Agriculture for advice. The experts favored the planting of *Ficus elastica* because this tree was a native of the East Indies, and declared that the soil and climate of Java and Sumatra were not suitable to *Hevea brasiliensis*. Therefore, large areas were planted to *Ficus*. An indication of this preference can be seen in the fact that in 1913 on the government's rubber plantations nearly 5000 hectares were planted with *Ficus*, as compared with a little more than 700 hectares with *Hevea*. The other rubber trees, *Manihot* and *Castilloa*, were also planted on a fairly large scale, but mostly mixed with other crops, especially coffee. However, the total area planted to these trees probably never exceeded 10,000 hectares, most of which was located in Java.

It soon became evident that *Ficus*, *Castilloa*, and *Manihot* were not equal to *Hevea brasiliensis* in either the quantity or the quality of yield; moreover, they could be tapped only after long intervals of rest, a necessity which made them less desirable from the point of view of harvesting routine. Consequently, the planting of these trees was abandoned; most of the old plantations have long since been converted into *Hevea*.

In 1876 and 1877, when the seedlings that grew up in Kew Gardens from Henry Wickham's famous shipment of *Hevea* seed from Brazil were distributed to the East, Java received a small number of plants. Two of these "original" trees are still growing in the Culture Gardens at Buitenzorg. Although some experimental plantings were made with seed from these trees, the bulk of the seed used for the new *Hevea* plantations in the Netherlands East Indies came from plantations established in Malaya and Ceylon before 1900.

Since rubber planting in the Netherlands East Indies had started somewhat later than it had in the other two countries, there was some experience available to the planters in Java and Sumatra. It is evident that the first plantations put in the ground followed the routine of Malaya and Ceylon in matters of planting, maintenance, tapping, and manufacture. These activities differed considerably from what is now regarded as standard estate practice. Clean weeding was considered necessary for the unimpeded growth of the rubber trees, and special weeding gangs kept the ground in the rubber gardens free from weeds and grasses. Tapping was done daily with the full herringbone system or the half herringbone system, both of which allowed from 4 to 6 cuts. Young trees were opened with a V-cut some 18 to 20 inches above the ground. With all these systems the time for bark renewal was four years, which was considered sufficient and an improvement upon the full spiral systems applied earlier, when the bark was removed from the trees in two years' time. Very close planting, usually 3 meters by 3 meters, was general, and thinning out was an operation as yet unheard of. The final product was turned out as smoked sheet or crepe by methods only slightly different from those used at present.

The location of the rubber estates in Java differs greatly from that in Sumatra. In Java,

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

the natives use most of the soil of the plains to grow rice and other food crops. Consequently, most rubber plantations are found in the hills, some as high as 700 meters above sea level. In Sumatra, on the other hand, with its much scantier population, there is no lack of land near the coast or along the rivers. Most estates are found on flat or slightly undulating terrain. In Java, the establishment of rubber plantations in the hilly part of the island led the planters to abandon clean weeding because of the disastrous soil erosion during the rainy season. Weeds and grasses, with the exception of the ill-famed *lalang*, were allowed to grow, sometimes in combination with terracing and silt pits. Soon the idea of covering the soil in the rubber plantations with a herbaceous carpet became general, and creeping plants, mostly leguminous, were considered a necessity when planting new land to rubber.

Lately, there has been a reaction against providing the rubber gardens with a cover crop; instead, a natural cover of shrubs and weeds which is slashed once or twice a year or kept reasonably far from the rows of rubber trees in order to facilitate tapping and supervision is allowed. This natural cover is a part of the so-called forestry method in rubber cultivation, which advocates less severe burning of the land before planting in order not to destroy the original forest growth completely, usually no planting holes instead of the one-half to one cubic meter large holes that for years have been standard, and planting with seed instead of stumps. There can be no doubt that the forestry method involves less expense for establishing new plantings and maintaining young as well as older plantations than does the heavy burning of the timber, and the planting and upkeep of a leguminous cover crop.

As already mentioned, on the first plantations, planting was close, often exceeding 1000 trees to the hectare. When tapped, at the age of 5 to 6 years, the trees were subjected to what is now considered very severe tapping. Consequently, the yields during the first four years, when tapping was done on virgin bark, were high. But when it had to be done on the four-year-old renewed bark, the results were disappointing. This fact, combined with other considerations, led to a change in the planting density, gave the impulse to thinning-out, and showed the necessity of adopting milder, *i.e.* less bark consuming, tapping systems.

In many cases the planting distance was doubled, so that only about 250 trees were planted to the hectare. Therefore, thinning-out was hardly necessary, because some trees never reached a tappable size, and others died from root diseases or wind damage, leaving a stand where the trees hardly hampered each other seriously. However, many estates continued a fairly close planting with 400 or more trees to the hectare. At first thinning was performed according to a rigid system, removing, for example, every second tree in alternate rows. But when it became generally recognized that the large differences in the yields of rubber trees are due not to the location of the tree in the planting, but to inherent characteristics, selective thinning or removing of the poor yielders became the acknowledged practice.

In order to locate the low-producing trees, the individual yield of each tree was taken either every day for 10 days or at intervals during a longer period. Assuming — it is now considered a fact — that poor yielders remain poor, these were removed in order to give the remaining trees more space in which to develop. The degree to which thinning-out was performed varied according to the views of the estate manager or owner; in general it can be said that the operation was carried out too far, as a consequence of the idea that the trees should receive sufficient "light and air" in which to develop freely. At present the tendency is to plant 400 to 500 trees to the hectare, and to thin-out, just before the trees reach tappable size, to about 250 trees; subsequent thinnings are either left to nature, or a few trees are removed in each following year. A definite optimum number of trees per hectare to be kept at a certain age of a plantation cannot be given because any such figure represents a compromise between the yield per tree and the yield per hectare. Within reasonable limits, the higher the number of trees, the higher the yield per hectare and the lower the yield per tree, and *vice versa*.

Fundamental changes in the methods of tapping rubber trees have also taken place. The full or half herringbone systems with daily tap were popular until about 1915. It should be noticed that, for the half herringbone tap, the cuts ran from right to left; but after the discovery that cutting from left to right yields more than from right to left, a change was made. The cause of the higher yield from the left-to-right cut is ascribed to the circumstance that the latex vessels in the bark do not run vertically but at an angle of about 6° from right to left; therefore with the left-to-right cut, more vessels are opened than with a cut in the opposite direction. The multiple-cut systems were abandoned about 1915 and replaced by one cut over ⅓ or ¼ of the circumference. The daily tap continued to be used in general; but in some localities where labor was scarce, tapping was done every other day. With lower rubber prices, alternate daily tapping was strongly favored as a means of lowering the cost of rubber. Other means of reducing the number of tapping days and consequently the cost were found in the so-called periodic tapping systems, whereby the trees are tapped daily for a period of two weeks or a month and thereafter rested for the same period. In Java the most popular systems became alternate daily tapping over one-half or a third of the circumference or tapping every third day over half the circumference. Bark consumption has been cut down sharply, so that the time for bark renewal is at least eight years. In Sumatra the periodic systems were used extensively; for young trees the period is two weeks, increasing as the trees grow older to one month or sometimes even longer. The length of the tapping cut is one-half the circumference, and the time allowed for bark renewal generally six years.

Recently there has been a return to more severe tapping systems. One is the so-called full-spiral, fourth-day tapping whereby the trees are tapped once in four days and rested three days; the cut runs in a spiral around the full circumference. Although bark consumption with this system is not greater than when the trees are tapped over half the circumference on alternate days, it must be considered more severe because more latex is taken out of the trees with one


FIGURE 87. — THE LIMBURG RUBBER PLANTATIONS, A TYPICAL RUBBER PLANTATION IN EAST JAVA.— *Courtesy Netherlands Information Bureau, New York City.*

tapping over the whole circumference than with two tappings over half the circumference. A few estates in Sumatra have been using this system, which undoubtedly is a means of increasing the yield and reducing tapping costs.

Another system, used especially in Java to increase the output of old seedling plantations, is making an extra cut 2 or 3 meters above the ground. The tapper has to use a ladder to reach this cut. The trees are tapped daily, one day on the lower cut, and one day on the higher cut. The system is quite sound and does not endanger the health of the trees.

The number of trees tapped by one tapper runs from 250 to 350, depending upon the size of the trees and the nature of the terrain, and also upon the prevailing price of rubber. In the old days, when multiple-cut systems were used, the tapping tasks were generally much smaller, sometimes as low as 100 trees or less. These very small tasks made tapping the biggest item in the cost price of rubber, often amounting from 60 to 80 guilder cents per kilogram ($0.16 to 0.20 per pound). With the one-cut systems and the reduction of the number of tapping days each year to 180 or 120, the tapping cost has now been lowered to a fraction of this amount.

The preparation of plantation rubber has, in principle, undergone few changes in the course of the years. Smoked sheet and crepe were the products turned out by the pioneer estates; they are still the standard products of the rubber plantations. In the beginning hand machines were used for crepeing and for rolling out sheets. With increased production engine-driven machines became necessary. Coagulation of the latex was formerly done mostly with acetic acid; but later on, formic acid came into general use because of its lower price. Before coagulation, the latex, which contains 30 to 40% dry rubber, is diluted with water to give a concentration of 15 to 20%. This is done in order to obtain as uniform a product as possible, and also in order to procure a soft coagulum which will pass through the mills in a shorter time than that from latex of a higher concentration. From time to time, special types of rubber have been prepared on a smaller or larger scale. Of these the most important is the so-called sprayed rubber, manufactured in very much the same way as milk powder. Two large factories for making sprayed rubber were erected, one in Sumatra, the other in Java; they worked for several years.

Rubber has also been shipped to consumers in the form of latex, sometimes the natural product as it comes out of the trees, but mostly in concentrated form, containing about 60% rubber. The concentration is achieved either through centrifuging the latex, or by creaming; in the latter case certain so-called creaming agents are added to the latex to separate the lighter cream from the heavier skim. Latex for shipment has to be preserved with ammonia or other chemicals to prevent coagulation. It is exported either in drums or in bulk.

The great variability in the yields of the *Hevea* trees, already mentioned, was recognized as soon as the first plantations were taken into tapping. One tree may give a full cup of latex; its neighbors may yield only one-tenth of the amount or less. It was found that some 30% of the trees of a planting produced about 70% of the total crop. The logical question, therefore, was asked. Would it be possible to establish plantations of only high-yielding trees, to avoid planting and subsequently thinning-out the low-yielding trees?

This problem was taken up by the rubber industry in the Netherlands East Indies some thirty years ago. Because most of the work connected with the attempts to solve this problem was carried out by the research institutes, it seems proper to give here a survey of their activities in the Netherlands East Indies.

At the beginning of the rubber planting era, the planters turned to the Department of Agriculture for advice. Before long, it was realized that there was a need for research workers who could devote their whole time to rubber problems. Plantation owners in Java as well as in Sumatra established several experiment stations which were run on a cooperative basis. In addition, some of the largest plantations later founded their own research departments.

As is usual for a new cultivation, the problems that drew the most attention were the symptoms of diseases; consequently, the phytopathology of *Hevea* was the first problem to be attacked. In the light of our present knowledge, we can say that the rubber plantations in the Netherlands East Indies have never been seriously endangered by any disease, although root destroying fungi may be very active in some localities. Diseases of the tapped bark have been studied, and methods for curing or preventing them have been worked out. Some diseases, such as brown bast and die-back, were found to be caused by improper agricultural practice, and have been reduced by changing to appropriate methods.

As early as 1914, it was found possible to propagate *Hevea* by bud-grafting. At that time it was believed that trees grown from buds transplanted from the twigs of high-yielding trees to seedlings would reproduce the yielding capacity of the high-yielder. It was thought possible thus to establish plantings consisting exclusively of bud-grafted, high-yielding trees. In the years following the discovery of bud-grafting of *Hevea*, many estates, cooperating with the experiment stations, were busy locating outstanding high-yielders, so-called mother trees, from which bud-grafts were to be made. A large number of clones (a clone consists of all the trees originating from the buds of a single tree) were made in this way. But when the trees eventually came into tapping, it was found that only a comparatively few clones possessed the high-yielding capacity that was expected from them. A satisfactory explanation of this discrepancy has not been found, but it is thought that at least in some cases the mother trees were not as outstanding as claimed, because records of their yield had not been taken systematically. The theory has also been advanced that, whereas the mother tree is being tapped on the trunk, a bud-graft possesses no trunk, but is in fact a branch. It is quite possible that the branches of a mother tree may have characteristics different from the trunk, as far as the yielding capacity is concerned.

Because low-yielding or mediocre as well as high-yielding clones developed, the experiment stations warned planters against the indiscriminate use of bud-grafts for planting purposes. Certain clones that gave good yields and showed no undesirable characteristics were approved by the experiment stations and recommended for planting. The extensive use of such "approved"

clones started about 1925. Since then, thousands of hectares have been planted to bud-grafted trees; at present the area of such rubber amounts to over 200,000 hectares or about 30% of all estate rubber in the Netherlands East Indies.

The expectation that double yield would be obtained from bud-grafted rubber in comparison with seedling rubber proved correct; instead of 500 kg. per hectare, a normal yield from mature seedlings, the bud-grafted plantings gave about 1000 kg. Considering that this extraordinary increase was achieved simply by selecting high-yielding trees in regular plantations, the result is certainly remarkable. It is expected, and not without reason, that the continued selection of mother trees and the isolation of clones will result in yields of 1500 to 2000 kg. per hectare. To obtain high-yielding trees which are to serve as mother trees for new clones, the experiment stations have undertaken the cross-breeding of high-yielding parent trees on a large scale. These activities, which have been carried out for the last 20 years, have given, as a result, a great number of seedling families with high yields, among them many outstanding yielders from which new clones have been isolated. Yield records from several of these clones show that they possess a yielding capacity far superior to that of the older clones.

Even before the experiments in cross breeding had been made, some estates had used selected seed — that is, seed picked from high-yielding trees — for new plantings; it was found that such plantings gave a higher yield than did those from unselected seed. With such selected seed the father tree is unknown and may be a poor yielder; therefore, better results could be expected if both parent trees were high-yielders. In order to obtain such seed in large quantities, seed gardens have been planted at various places in the forests of Java and Sumatra, and at such distances from existing rubber plantations that pollination from outside is practically impossible. Each seed garden is planted with two high-yielding clones, or in some cases several clones. The yields of plantings with seedlings from such "clonal" seed has proved very satisfactory; however, it seems doubtful that quite as high yields will be obtained from these plantings as with bud-grafts from "approved" clones.

In the field of selection, it is necessary to consider not only the choice of clones, but also that of stock; that is, the young seedlings on which the buds are grafted. It has been proved experimentally that for some clones the use of stock of a certain origin results in higher yields than does the use of other stocks. The problem, however, needs further investigation before definite recommendations can be made. In this connection it should be mentioned that it has been found that the use of the hybrid between *Hevea brasiliensis* and *Hevea spruceana* as stock has considerably increased the yield of the clones experimentally tried.

In the evolution of the tapping system, the experiment stations have played an important role by setting up field experiments through which to solve the problems under investigation. The data accumulated from numerous field experiments have demonstrated the advantages or disadvantages of the various tapping systems, and have formed the foundation of the advice which has been given the planters. The general tendency in tapping has been simplification and standardization; the several complicated systems introduced from time to time have been experimentally proved to have no special advantages. The main points in the choice of a tapping system are the length of the cut, the frequency of tapping, and the rate of bark renewal. With the systems in use at present, the danger of tapping the trees too hard is avoided; on the contrary, it might be said that in several cases under-tapping occurs.

Considerable work has been done by research workers in the Netherlands East Indies with regard to the study of the physiology of the *Hevea* tree. Most of these investigations have been concerned with the system of latex vessels in the bark, the origin of latex, the dynamics of tapping, and the relation of yield to anatomical and physiological properties. Although many problems still remain to be solved and further investigations of several points are badly needed, the results so far achieved have greatly widened and deepened our understanding of the characteristics of *Hevea* as a rubber-producing plant. Our knowledge of the location of the area of the bark that is drained by a tapping cut makes it clear why herringbone tapping should be avoided, and why two cuts made on one tree should be located at a considerable distance from each other. We also understand that the number and the size of the latex vessels are not the only factors that determine the yielding capacity of a tree, as was formerly believed, but that the physiological properties of the vessels play a very important role in the flow of latex.

The incidence of the brown bast disease of the bark declined greatly after it was discovered and acknowledged that the disease was a physiological degeneration of the bark caused by too heavy tapping, and that the remedy was the use of milder tapping systems. Investigations of the anatomy of the bark have also taught us some important facts which have been immediately applied. Mention has already been made of the discovery that the latex vessels do not run vertically in the bark, but at an angle of 6° from right to left; hence the higher yield comes from a cut from left to right. To secure the maximum yield, tapping must be deep because most latex vessels are located near the cambium and there are only a few and narrow connections between the concentric layers of vessels.

The experiment stations have always been opposed to clean weeding; they are to no small extent responsible for the fact that soil conservation through the application of cover crops early became general in Java as well as in Sumatra. Many cover crop plants have been introduced and tried under various conditions; at present their number is reduced to a few standard species, nearly all of which are leguminous.

The problems of planting density and thinning-out were attacked by field experiments as well as by purely statistical methods. The importance of close planting and early thinning-out in the case of seedling rubber has been demonstrated; on the other hand, it was found that thinning-out in old plantations is an unnecessary operation that does not noticeably increase the yield of the remaining trees. Even for bud-grafted rubber it is recommended that a larger number of trees be planted than will be kept when the trees come into tapping. The reason is that the bud sometimes dies or does not develop into a tappable tree. With this kind of planting material, there

may therefore be more vacancies than with seedlings. Thinning-out of a bud-grafted planting is done according to the size of the trees; it has been found that there exists a close correlation between the circumference and yield of trees belonging to the same clone.

The fertilization of rubber trees has never been generally practiced in the East Indies. Through widespread field experiments the research stations have ascertained that in only a few instances does fertilization affect the yield of *Hevea* plantings. In Sumatra certain low-lying clay soils respond to nitrogenous fertilizers, and in Java there are some small areas with poor lateritic soil that need phosphate and potash as well as nitrogen for a satisfactory rubber production. In several cases it has been found that fertilization, especially with phosphate, has a beneficial effect on the growth of young *Hevea* plants in nurseries. The application of phosphate on the same kind of soil to rubber already in tapping does, however, not necessarily result in an increased yield, although frequently an accelerated growth of the trees has been recorded.

The research stations have carried out experiments to arrive at standardized methods for the preparation of rubber. Various coagulants and anticoagulants have been tried in the course of the years and their advantages or disadvantages made known to the industry. Materials for such tools as tanks, coagulation pans, and sieves used in the factories have been tested for their usefulness. The performance of the milling equipment has been investigated. Studies have also been made of the defects of prepared rubber, and of measures to be taken to avoid them. At various times the experiment stations have published handbooks about the preparation of rubber. There is little doubt that these publications have contributed greatly to the establishment of uniform methods in the rubber factories.

For several years, investigations of the physical properties of crude and vulcanized rubber were carried out in Java in an effort to procure a rubber with uniform properties. The idea was to interest the rubber manufacturers in the United States and Europe in such rubber which, it was hoped, would receive a higher price than ordinary estate rubber of unknown properties. These attempts failed, however, and rubber is still marketed and priced according to its external appearance.

Latex has been subjected to numerous investigations; our knowledge of the chemistry of latex has been extended largely through studies carried out in the research laboratories of the Netherlands East Indies. The physical properties of latex have also received attention, especially in connection with the preparation of concentrated latex either by centrifuging or by creaming. The first experiments with separating latex into cream and skim through centrifuging were performed or supervised by the experiment stations. In the search of new effective creaming agents, valuable discoveries have been made.

The growth of the rubber planting industry in the Netherlands East Indies began in the boom years of 1910 to 1912. After a period of lower rubber prices, planting on a large scale was again resumed about 1916. The planting activities came to an end with the sharp decline in the price of rubber in 1920 and 1921. With improved prices in the following years, rubber planting expanded as never before. This period lasted until 1930, after which date comparatively little planting has been done. In 1934, when the rubber-producing countries of the East agreed to restrict the export of rubber in order to stabilize the price, the planting of rubber was prohibited; later on extensions not exceeding 5% of the area already under cultivation were allowed. Conversion of old seedling rubber into bud-grafted rubber was, however, permitted up to 20% of the total area. This change was made by a great many estates, although not on a very large scale. In 1941 the total area of estate rubber in the Netherlands East Indies was some 700,000 hectares, of which over 200,000 hectares were bud-grafted trees. The number of rubber estates, which with a few exceptions are located in Java and Sumatra, amounts to about 1200.

Rubber, perhaps more than any other commodity, has experienced tremendous variations in its selling price. With each decline in selling price the estate managers had to adjust their cost price to new levels. It is interesting to note that in the year 1913 the cost price per kilo of rubber on 25 estates in Java ran from fl. 1.16 to fl. 3.46 (about $0.30 to 0.90 per pound); it was then thought it would be possible to bring it down to fl. 0.90 ($0.23 per pound) in the future. These very high cost prices were, of course, due in part to the small size of the plantations and the low yield from the very young trees. In the subsequent years the cost price was reduced considerably, partly through increased yields, partly through the change to more economic tapping systems and a more efficient factory practice.

In the years 1930 to 1935, however, the price of rubber dropped to such a low level that even the most rigorous economies on the estates could not force the cost price below the selling price. Numerous estates closed down, and others confined tapping to their high-producing areas. It is estimated that during that period the rubber plantations in the Netherlands East Indies suffered a loss of 630,000,000 guilders (about $365,000,000). Although there are estates that are able to produce rubber at $0.06 to 0.08 per pound, for the majority of them the economic level lies above $0.10. Between 1930 and 1940 from 100,000 to 200,000 hectares of tappable estate rubber lay idle for several years; these areas were mostly low-producing plantings, unprofitable to tap at the prevailing prices. In 1941, when the demand for rubber was great and the prices had risen, the production from estates reached the record figure of 300,000 tons.

In the East Indies, rubber is grown not only on large estates, but also in literally hundreds of thousands of small gardens belonging to the native population. Nearly all this rubber is located in Sumatra and Borneo and some small adjacent islands; in comparison the area of such rubber in Java is very small. The cultivation of rubber by the indigenous population, generally known as "native rubber," started shortly after the establishment of the first estate rubber plantations. In the beginning the expansion was slow, so that up to 1920 probably less than 150,000 hectares had been planted. Large scale planting started about 1925. It is estimated that within the next five years more than half a million hectares were put in the ground. The exact size of the planted area was unknown until 1936 when

a census revealing that the number of trees on native holdings amounted to about 582,000,000 was taken. Assuming about 850 trees to the hectare, this meant that the planted area covered some 680,000 hectares. Even at the time these staggering figures were published, it was admitted that they represented a minimum, and that the real figures were expected to be much higher. A second census was taken, and from the new records it is estimated that the area of native rubber in the East Indies exceeds 1,000,000 hectares. This implies that the native rubber has surpassed the estate rubber by more than 300,000 hectares.

The methods of planting, maintenance, tapping, and, to a certain degree, preparation, followed by the native population, differ considerably from those employed on the estates. Long before rubber was introduced in the East Indies, the natives used to fell and burn the forest for their rice cultivation. A spot cleared from forest is known as a *ladang*, and the rice planted there is dependent upon rain for its growth, in contrast to that grown on *sawahs* or irrigated rice fields. Generally rice is planted on a *ladang* for two years, after which the site is abandoned, and a jungle growth, called *blukar*, allowed to develop. For their rubber plantings the natives use the *ladangs*, and plant rubber seed simultaneously with the rice. When the second crop of rice has been harvested, the rubber trees are already more than a year old. Planted very closely, they have the start of the *blukar*, most of which originates from the seed of trees growing in the vicinity of the *ladang*. It should be emphasized here that the trees and shrubs which form the secondary forest called the *blukar* are plants that do not thrive in the shade, and are not found in the virgin forest. *Hevea*, on the other hand, can stand shade very well. From these considerations it is clear that competition between the rubber and the *blukar* is one-sided, and that the advantage lies wholly on the side of the former. No maintenance is given the young plantations. When the rubber trees become tappable — with the very close planting this is after about seven years — the slashing of such *blukar* as may impede tapping is the only operation necessary.

Most of the native rubber plantations are small, the average size being less than one hectare; this means that there are more than one million owners of small holdings in the East Indies. On plantings smaller than 2 or 2¼ hectares — and that is most of them, whether one considers their number or their total area — tapping is done by the owner and his family. Larger plantings have to employ hired labor. From this, it is evident that the amount of rubber derived from native holdings is not to any great extent dependent upon the labor available, but chiefly upon the price the owner can get for his product. Conditions vary considerably, however, from one district to another. In regions where larger holdings are the rule, there has developed a kind of share system, whereby the tapper receives his pay in the form of rubber, generally half the amount he has collected; when prices are low, he may demand a larger share — as much as ¾ of the crop, and in extreme cases the whole crop. In return, he takes care of the food crops and other commercial products of the owner.

For the owners of holdings on which the family does the tapping, the extent to which tapping is continued when prices are low depends upon the availability of other means of existence. In some regions where coffee, pepper or coconuts are also cultivated, these crops may pay a better price; consequently tapping is curtailed. Or the rubber owner may turn to collecting forest products, such as rattan, sago, gambir, and gums. But in some districts the population is almost wholly dependent upon rubber production for obtaining cash; there declining rubber prices may increase production instead of lowering it. It should be noticed, however, that no matter what the price of rubber may be, the owner of rubber holdings always uses his *ladangs* to grow rice for himself and his family. Rubber is grown in order to get cash; it has proved to be a money crop superior to most other crops and forest products. The population of Sumatra and Borneo will continue to plant rubber on the *ladangs*. It is easy to grow, easy to harvest, and easy to prepare; the climate is suitable for it; and there still is land in abundance available for more rubber.

The native rubber producer does not follow any well defined "tapping system." As a rule, the tapping cut runs over half of the circumference; but if prices are high, several cuts may be made, and even the larger branches of older trees may be tapped. Tapping is done daily, except when labor is scarce or the family cannot tap the whole area in a single day. In such cases the trees may be tapped only once in two days or twice in three days. Periodic tapping, whereby the trees are rested either because of unattractive rubber prices or overtapping, is also applied.

Considering that no attention is paid to the maintenance of the plantings and to diseases, and that tapping is frequently severe, it is surprising that the native rubber is generally in a rather satisfactory condition. The incidence of brown bast, which is caused by heavy tapping, is not alarming, no doubt due in part to the involuntary resting periods given to the trees. Root diseases do not seem to occur frequently, which may be connected with the fact that the *ladangs* are rarely made in virgin forest where root destroying fungi are abundant, but mostly in old *blukar* where the repeated burning has reduced the number of roots in the soil and so created conditions unfavorable to the growth of fungi.

All those who have made careful investigations of the production of native rubber gardens have stated that the yield is high and superior to that of estate rubber plantings from the same planting material, unselected seed. These investigations do not refer to incidental tappings, but to yield records taken during longer periods from plantings in regular exploitation. An average figure of 600 kilos of rubber per hectare has been mentioned. This does not seem exaggerated, for the daily tapping of 850 trees per hectare would mean an average yield of no more than 2 grams of rubber per tree per tapping.

The government has tried to furnish the native rubber growers with selected planting material. The interest in bud-grafting has proved negligible, probably because of the work involved. On the other hand, the natives have been keen buyers of seed from clonal plantings of the estates. The agricultural service of the government has established isolated seed gardens planted with high-producing clones in order to supply the native rubber growers with seed of a high-yielding potentiality.

For coagulating the latex, the natives have been using alum in preference to acids, mainly because it is easier to transport. In recent years,

as the result of government propaganda, they have changed to acetic or formic acid, which is preferred by rubber manufacturers. Because of the lack of machinery for milling, a large part of the rubber — in the beginning, nearly all of it — has been shipped as coagulum, generally called slabs. These slabs measured about 50 by 40 by 15 cm. The water content ran from 10% to 50%. They were exported to Singapore and there, mostly in Chinese-owned remilling factories, milled into a thick crepe, called blankets. As the production of slabs increased, large remilling factories were established at various points in the principal regions of native rubber production in the East Indies. In recent years the export of slabs has diminished considerably; in the years 1938 to 1941 it amounted to only 2 or 3% of the total native rubber production. The importance of the remilling industry can be shown from the fact that in 1941 more than a third of native-produced rubber was exported in the form of blankets.

Since the price which the natives receive for their rubber when sold as slabs, is in general considerably less than when they market it as smoked sheets, there has been a strong movement, supported by the government, to encourage the preparation of sheets. In some districts the manufacture of smoked sheets started at an early date, although it must be admitted that this rubber was of a rather poor quality from a dealer's viewpoint. As a matter of course, the natives use hand driven sheeting machines exclusively; these are of various constructions, the rollers being either smooth or grooved, and made of either hardwood or iron. The quantity as well as the quality of smoked sheets from native holdings has been increasing considerably. In 1941, when the export of native rubber reached 338,000 tons, nearly two-thirds of it was prepared in the form of smoked sheets. It is of interest to note here that this exportation, the highest in the history of native rubber, represents only a part of the volume that could be produced by all-out tapping. It is quite conceivable that the potential production of native rubber in the East Indies at present exceeds 600,000 tons a year.

# HYDRODYNAMIC RESEARCH IN THE NETHERLANDS INDIES

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In the Hydrodynamical Laboratory of the Department of Roads and Waters at Bandoeng, which in May 1941 celebrated its twelve and a half years anniversary, a number of experiments have been performed for 200–300 different projects of flood control, both for the government and for private interests. The institute has a pumping capacity of 850 liters per second and has a laboratory space with a floor area of 1820 square meters. Figures 88 and 89 give a picture of the two laboratories.

Here follows a survey of the more important hydrodynamic work performed in this institute.[1] We deal in particular with those tests which have led to essential modifications in the construction of flood control projects or in the resulting computations.[2]

**Fixed Dams.** — Most of the observations on this subject were undertaken to find a convenient shape for fixed and overflow dams.

Before 1930 the cross section of this kind of structure had developed into a type which we may conveniently call the "standard" (or B.O.W. type). It consists of a wall with a downstream face of batter 5:1 with an adjacent horizontal apron on the downstream side. This form was generally held to be the best in practice and it was regularly followed in actual construction. Despite the fact that there were no fixed rules for the depth and the length of the apron a certain uniformity was reached by relying on the eye and a feeling of balance.

After the introduction of the experimental tank with glass walls, in which all kinds of two dimensional models could easily be placed, the "standard" type was the first to be subjected to comparative tests. It was compared with other types like the older overflow basin, the tooth sill according to REHBOCK, which was new at the time, the slightly inclined floor, with or without a rectangular sill of cubic blocks, the circular pool and the apron covered with obstacles.

The result was rather astonishing to many observers, since immediately downstream of the "standard" type by far the largest erosion occurred. This traditional type appeared to be the least convenient one.

The experiments showed considerable differences in the various types. In the case of an apron without a sill the water produces a deep pool immediately downstream from the dam, and with a sill of fair dimensions the erosion only appears at some distance downstream from the sill. On the downstream side of the tooth sill, according to REHBOCK, an erosion occurs with a usual slope of 1:4. Cubic blocks at the end of a floor inclined upward at ratio from 1:5 to 1:10 act very favorably, but are rather vulnerable, so that preference is usually given to a continuous rectangular sill, which also guarantees a favorable result. The circular basin is preferred if there is fear that rolling pebbles may have too

* Based on the author's "12½ Jaar Hydrodynamisch Onderzoek aan Waterloopkundige Modellen in Ned.-Indië en hydraulisch research-werk in het algemeen," De Ingenieur in Ned.-Indië 1941, Section II, pp. 82–93, 1941).

[1] After an address given on May 23, 1941, at Bandoeng, at the occasion of the 28th annual meeting of the Association of Waterways Engineers in the Netherlands Indies (Vereeniging van Waterstaatsingenieurs in Ned.-Indië). — A number of additional illustrations and a list of references will be found in the original publication.

[2] More detailed information will be found in *De Waterstaatsingenieur* (1929–33) and *De Ingenieur in Ned.-Indië* (1934–1941).

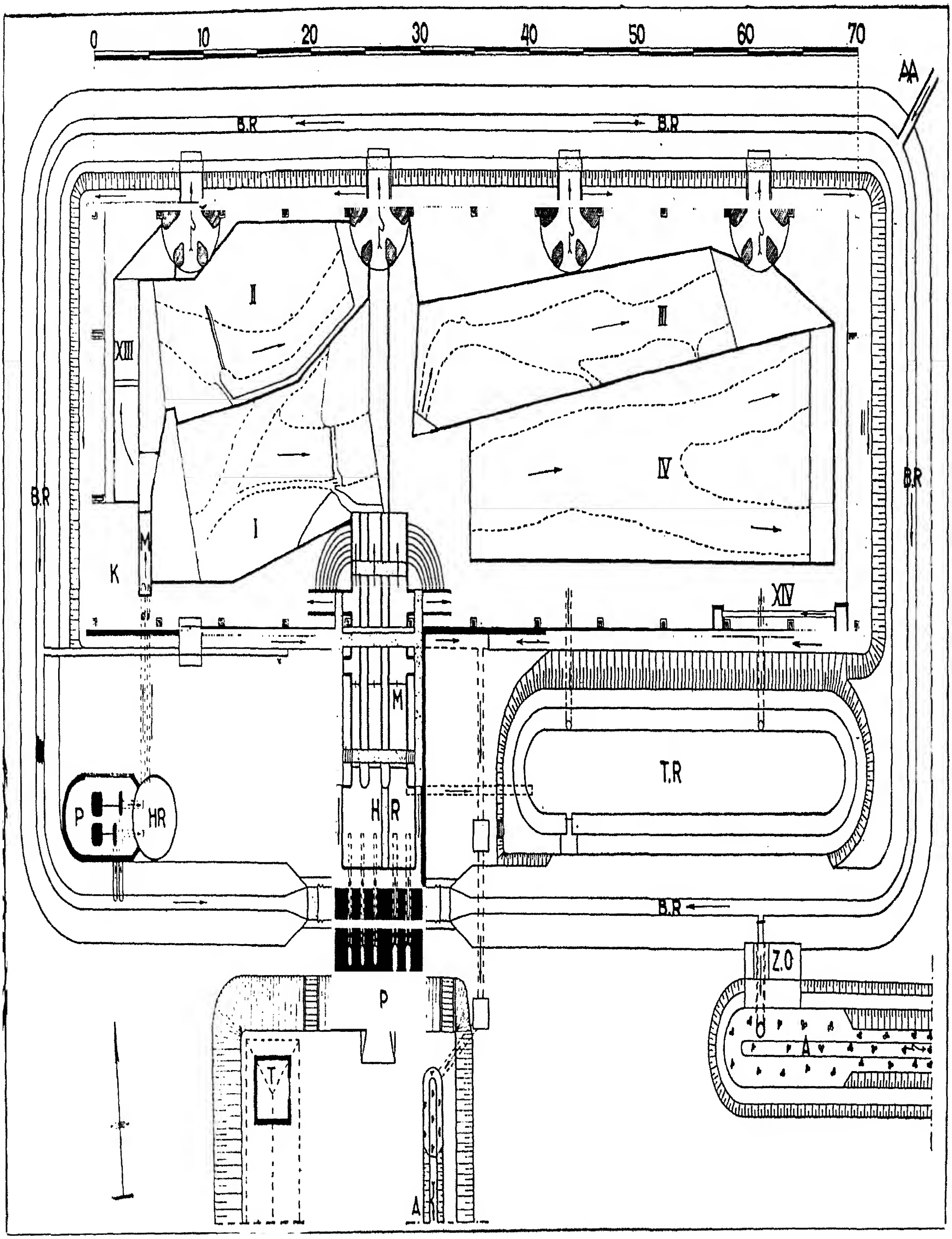



FIGURE 88.—HYDRODYNAMICAL LABORATORY, DEPARTMENT OF ROADS AND WATERS.—I, 1:40 model Laimbo dam (Celebes); II, 1:33⅓ model Batang Tabir dam (Djambi); III, model Beraoe river (Borneo) at the location of the Hadji bank; scales: altitude 1:50, length and width 1:250; IV, model both branches along P. Pajong in the estuary of the Moesi (Sumatra); scales: altitude 1:40, length and width 1:200; XIII, systematic investigation of the outlet across Cipoletti-, Thomson- and Poncelet weirs; XIV, determination coefficient of resistance of sulphur pulp in rubber tube; BR, concrete circular gutter serving as low reservoir, content 400 cubic meter; P, 5 pumps with total capacity 500 liter/sec., 2 pumps with total capacity 250 liter/sec.; HR, high reservoirs, content 18 and 30 cubic meter; TR, intermediate reservoir, content 125 cubic meter; M, measuring instruments according to REHBOCK; AA, inlet; A, outlet; K, office; ZO, lateral overflow with drainage sluice.

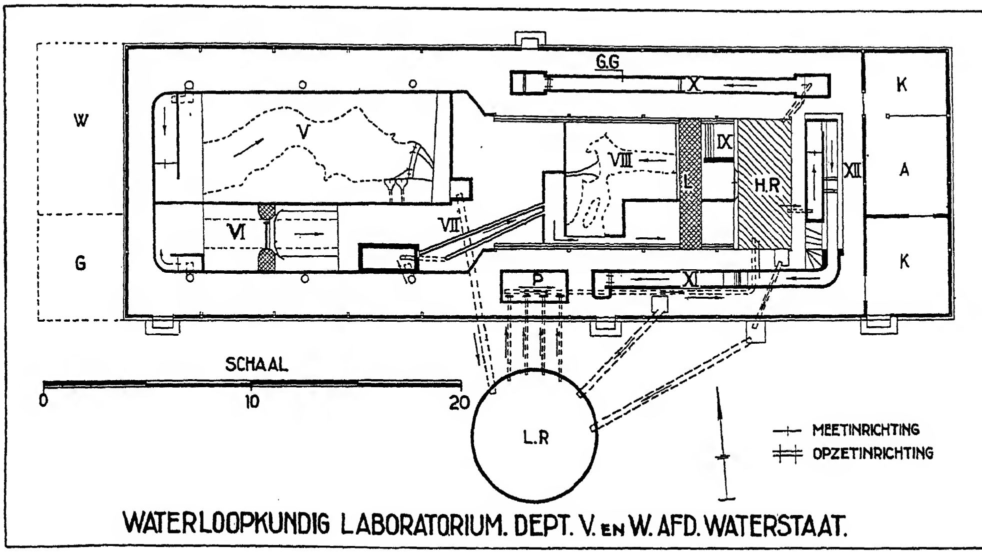



FIGURE 89. — HYDRODYNAMICAL LABORATORY, DEPT. OF ROADS AND WATERS, Section Waterways.—V, 1:33 1/3 model dam with inlets of 70 cu.m./sec. in behalf of the power station on the Asahan river; VI, 1:33 1/3 model Gloempang dam (Atjeh, Sumatra); VIII, model free outlet of 15 cu.m./sec. from Kr. Pensangan; scales: altitude 1:20, length and breadth 1:50; X, systematic investigations concerning the shape of dam crests; XI, systematic investigations of the most convenient depth and length of the aprons and altitude of the end sill; XII, systematic investigations concerning the depth of pools for various bottom material in behalf of sill dams, LR, low reservoir, content 75 cubic meter; P, 4 pumps, total capacity 100 liter/sec.; HR, high reservoir, content 5 cubic meter; GG, gutter with glass walls; K, office; A, archives; W, workshop.

strong an effect. The larger the radius of the basin, the smaller is the chance of damage through collision.

We must add that in all these experiments the downstream water level at bandjir (extreme flood) came to the crest of the spillway, so that the overflowing water splashed into the tail-water. The motion of the water changes entirely in the case of a regulated spillway with a large overflow ratio, in which case the overflowing water remains in waves on the surface. A very critical stage is the transition between both conditions of motion, which appears when the ratio of overflow $\frac{h_2}{h_1} = .70 - .75$. In this case we might speak of a fluttering flow. This does not follow the downstream face of the spillway any more but hits the unprotected bottom immediately below the structure. It is lucky for our dams that this condition is unstable and will in practice not occur for any length of time.

There was originally some scepticism when the bad results of a horizontal floor without an end sill came to light. After the result was repeatedly confirmed the "standard" type was entirely abandoned.

Examples are the spillway of the Gembong reservoir and the Setail dam of the Baroe works. After model experiments at Semarang and at Bandoeng respectively slightly inclined floors with low end sills were built.

Fig. 91 shows that in this case relatively small differences either in the slope of the floor or in its length and depth continue to have an important influence on the magnitude of the erosion. Both cross sections are given and a numerical factor indicates the fitness of each construction.

Another remarkable example is the Kaliwadas dam in the Pekalongan section (*see* A. M. VERSCHOOR, *De Ingenieur in Ned. Indië*, 1935, No. 4.). After repeated continuations of the apron as a measure against the results of an eroding river bed below the dam the coffer dam was again in the open. Further continuation of the apron to such a depth that a horizontal floor would not be necessary would have been very expensive. A project was therefore made with a horizontal floor of sufficient depth and strong enough to resist the impact of rolling pebbles, which hit it with a velocity of more than 10 meters a second. The project was estimated at fl. 65,000.

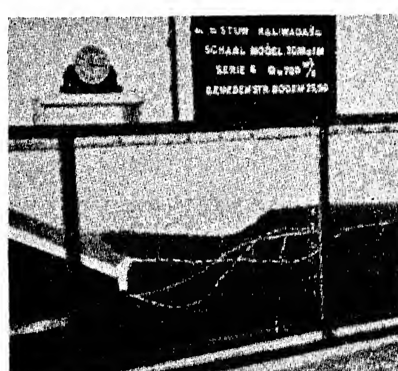


FIGURE 90. — MODEL OF KALIWADAS DAM. The pool is indicated by the dotted line. The dash-dot line indicates the favorable erosion line after the sill was placed.

Since there was a danger that by continued deepening of the river bed there would be shooting flow over the apron, leading to an undesirable

condition, other solutions were sought with the aid of models.

At the start of the experiments the existing situation was imitated as well as possible. This was obtained by the use of fine gravel for the construction of the downstream bed, which in reality had a padas-like structure. The result was a pool which in the model corresponded, in fair approximation, to the actual erosion measured after a western monsoon (Fig. 90).

After a sill of 1.50 meters height was placed at the end of the apron a much more favorable erosion line was obtained. The flow has been directed upward and in this way an overflow dam with jump is formed, whose end is lower than the downstream bed, so that even with small discharges there will be no uprooting of the coffer dam (Figs. 94–97).

The sill was built in reinforced concrete for about fl. 10,000 and the results corresponded entirely to expectations.

The hole below the dam, which was about five meters deep and ten meters long, was soon filled with sand and pebbles. It was only necessary to provide the sill structure with a row of vertical rails to obtain protection against serious damage.

It is therefore very well possible to obtain a satisfactory form through experiments with models. This is, however, not always of practical value, since it implies the building of a model for every new dam to be constructed. It was possible to draw some general conclusions from the many experiments performed in the different laboratories of the Indies, but there was nevertheless no simple practical rule to be applied to the many dams to be built. Professor SCHOKLITCH established such a rule for a stilling pool and a rather high end sill, by making the dimensions of all parts dependent on a few fundamental quantities.

Though the Schoklitch basin was really only intended for very high overflow drops, such as only occur on high dams and on spillways of reservoirs, this form has also been recently used on other cases in the Indies. It has been gladly accepted, because of the general applicability of the rule, despite its rather complicated form.

When this rule became better known the Hydrodynamical Laboratory of the Dept. of R. and W. began systematic investigations concerning the most favorable depth and length of aprons and the height of the eventual end sill.

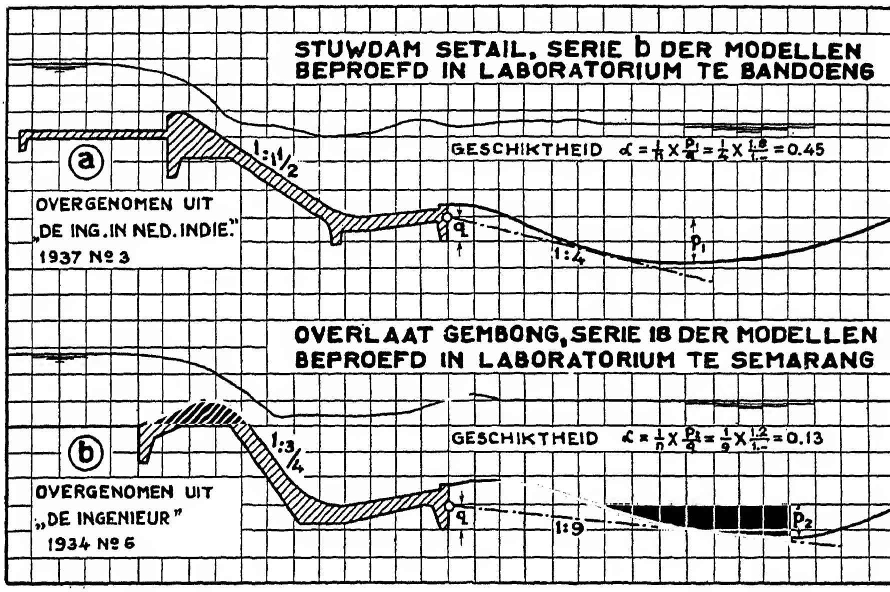



FIGURE 91*a*. — SETAIL DAM, series *b* of the models tested at the Bandoeng laboratory.
Fitness $\alpha = \frac{1}{n}\frac{p^1}{q_1} = \frac{1}{4} \times \frac{1.8}{1.0} = .45$

FIGURE 91*b*. — GEMBONG OVERFLOW, series 18 of the models tested at the Bandoeng laboratory.
Fitness $\alpha = \frac{1}{n}\frac{p^2}{q_2} = \frac{1}{9} \times \frac{1.2}{1.0} = .13$

This work took much time, for it was necessary to establish the influence of no less than five variables. The result can be summarized by a reference to Fig. 92. A convenient form is obtained for a downstream slope of the spillway of 1:1 and a short horizontal apron with a continuous rectangular end sill, if the following conditions are satisfied:

$$D = L = R = 1.1\,Z + H,$$
$$a = (.15)\,H\sqrt{\frac{H}{Z}}.$$

Since this rule leads to short and somewhat deeper lying aprons than follows from the theory of the hydraulic jump, it is less recommendable for those regulated spillways, for which $\frac{Z}{H} = .5$. In such cases it is better to apply somewhat higher and longer aprons. A guide to this case is in preparation.

There have also been many experiments concerning embankments, which have led to some results. Certain forms which lead to favorable results with a minimum of erosion were obtained.

An embankment diverging from the dam appears to have a favorable influence because of the spreading of the overflowing sheet. In some cases fan-like spreading had to be obtained artificially by radially placed orifices, conical aprons or circular sills.

It has moreover been established that the vertical walls behind which the downstream embankments can remain unprotected are less satisfactory for overflow dams and can be better used as lateral borders of orifices through which water runs, as in movable dams or sluices.

of the discharge under different types of regulation was possible. This method has not only soon been accepted in the Neth. Indies, but formed also the foundation of the experiments of FENDT in the Hydrodynamical Laboratory of Munich.

Some shortcomings still exist and will be tackled in some supplementary experiments at Bandoeng.

Another part of the fixed dam, which model experiments have influenced considerably, is the sluiceway. Here again existed a form taken

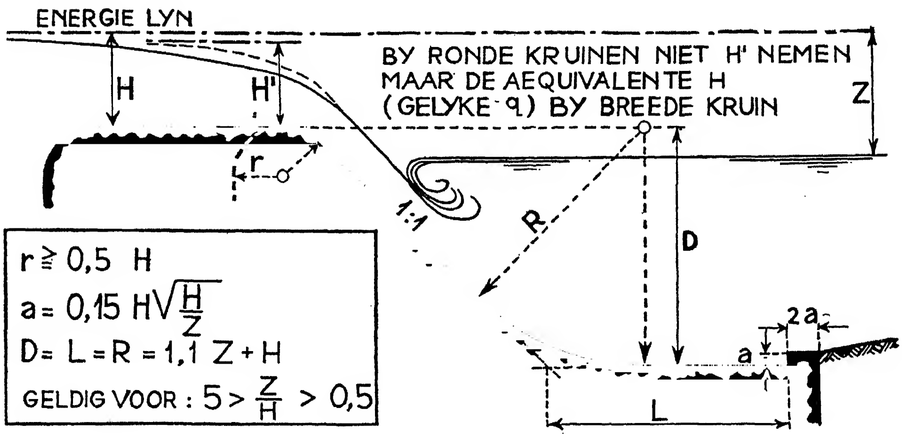



FIGURE 92. — MOST FAVORABLE SHAPE OF DOWNSTREAM POOLS BEHIND SPILLWAYS. The dot-dash line is the line of energy. For round crests H[1] should not be taken but the equivalent H (equal q) for broad crest.

Another problem which we meet in the case of fixed dams is the correct shape of the crest.

This problem did not receive much attention in previous years. Through the model experiments in this country, however, the ancient rectangular or trapezoidal crest has been replaced by one of a circular or otherwise streamlined cross section. The object was to obtain a maximum coefficient of discharge by establishing the highest possible curvature of the overflow sheet which does not detach the water and does not cause too much friction. For a circular head with a radius equal to one-half of the overflow height and an upstream flow at a distance equal to the radius below the crest the coefficient m in the well-known formula $Q = mbd\sqrt{gd}$ is about 1.30. The model of this case registered the positive and negative pressure along the crest at seven points by means of the water levels in the corresponding piezometer tubes. It followed that a downstream face of batter 1:1 or 4:3 has certain advantages. This diminishes the suction considerably, so that the line of pressure gradient tends to remain above atmospheric pressure and makes the construction easier and cheaper.

In the Laboratory at Bandoeng these systematic investigations are still continued in order to reach a practical solution of this problem.

The discharge determination for regulated spillways caused more difficulties. Before the time that experiments were made on this question many formulas were in use, which gave only poor results. This was corrected in 1932, when after some experiments in Semarang and some compilation of observations from elsewhere it was shown that a practical mode of computation

from practice, the so-called open sluiceway with a pier reaching to about the front of the inlet. The best we can say of it is that it was an improvement on former conditions and that it was possible to maintain the irrigation with it.

The insufficiency of this form appeared when models were used to study the sluicing effect. It could be clearly demonstrated that sluicing and admitting at the same time is not desirable because of the penetration of bottom matter into the inlet. This seemed to show that admittance and discharge had to be alternated. The objections against such an exploitation led to the plate construction with undersluicing, with which under circumstances the discharge can be continuous. A further step was that the sluice pillar was entirely abandoned, since it is only in the way and an obstacle to a uniform discharge across the dam.

The inlet sill, in this case, has to be provided with orifices for the discharge tubes which run underneath the inlet sluice. An example is the draining of 50 cubic meters a sec. from the Batang Tabir in behalf of the colonisation in Djambi, which project, made up by the Hydrodynamical Laboratory of the Dept. of R. and W., is represented in Fig. 93.

There are no sufficient data yet to compute the capacity of these discharge tubes and the most desirable velocity inside of them for different bottom materials as rolling pebbles, gravel and sand.

It is remarkable that in some cases sluiceways can be entirely omitted. Sluiceways have been built which are never used, or, at any rate, never have to be used. This may happen in any case

where the inlet lies at the outer side of a bend, when at the place of discharge a depression of the bottom is formed in a natural way and the solid matter is moved over the dam at the opposite side. This bend action is actually used in many cases for free drainage. For relatively small inlet flows this can also be done by placing the outlet in a wall placed obliquely on the dam. An example is the Semiredjo dam near Pati.

**Movable Dams.** — The only experiments performed in this country concerning the devices for teristics, in which the remarkable properties of the different types are clearly registered, and which also allowed all kinds of corrections.

**Siphons.** — Automatic valves have often been used in India, but not siphons, which also are constructed in order to regulate the water level automatically. The systematic experiments taken with different kinds of siphons have shown many imperfections in the traditional types, so that there was often considerable hesitancy with regard to the use of siphons.

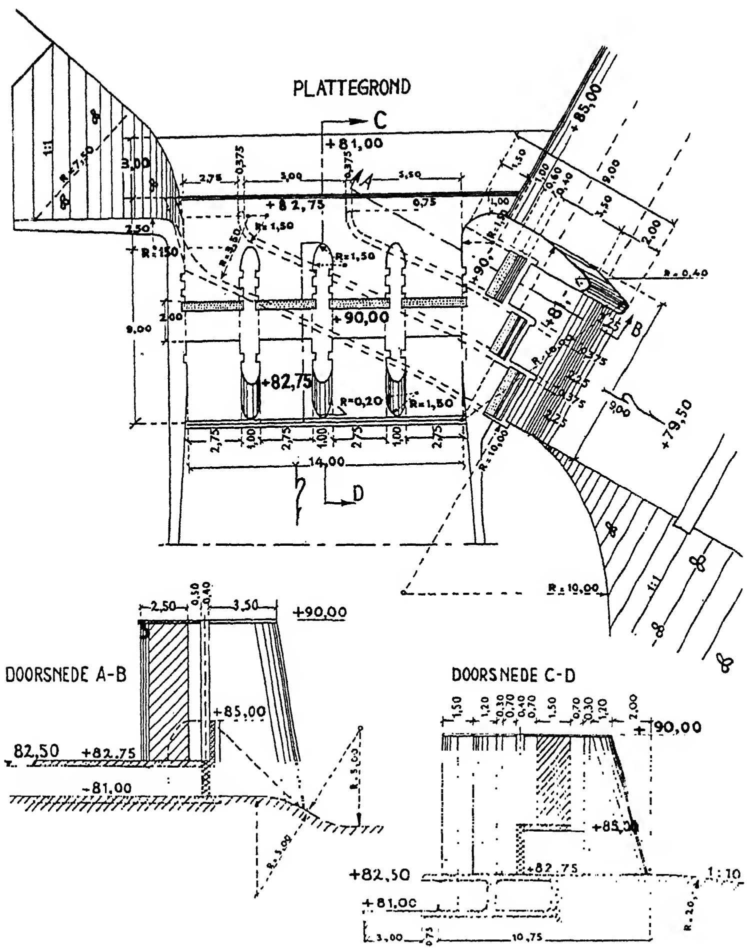
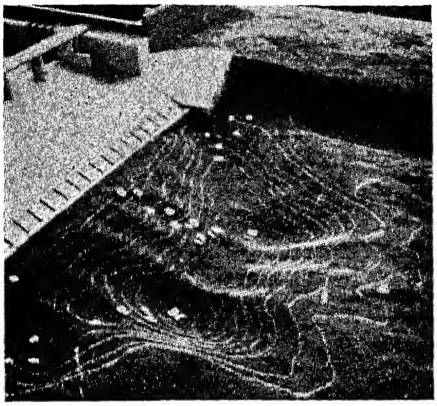



FIGURE 93. — DRAINAGE FROM THE BATANG TABIR (inlet with discharge tubes running underneath the sill). *Above* is the plan, *below* are two cross-sections.

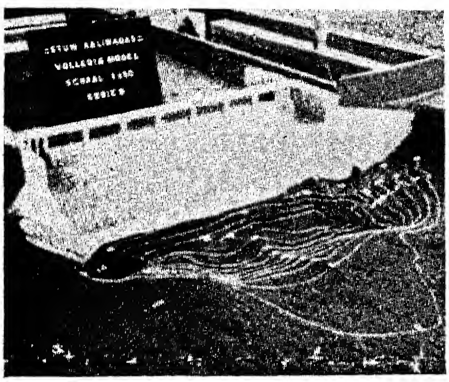
the control of water in movable dams deal with automatic valves. In one case the hydraulic action of such valves with submerged turning point has been investigated. The development of the automatic level regulator, the so-called suspending valve, in the Netherlands Indies, contrary to other countries, where this type is hardly ever used, has been mainly due to the many model experiments to which it has been subjected. These experiments made it possible to investigate its hydraulic character and to record it in characteristics the relations between flow, head and tail water level for some usable types, so that effective constructions can now be projected with considerably more security.

**Measuring Installations.** — The experiments have also brought a considerable progress in the measuring technique of irrigation, notably of Venturimeters, Crump-de Gruyter sluices and the apparatus with constant velocity (*see* DE



— FIGURE 94. —

— FIGURE 95. —



— FIGURE 96. —

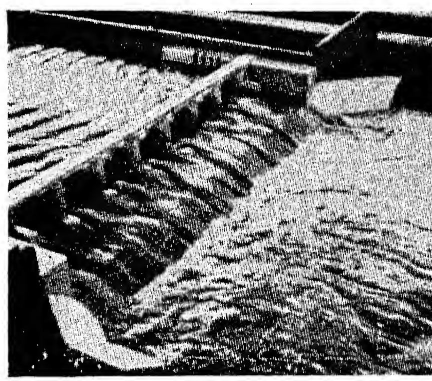


FIGURE 97. —

FIGURES 94–97. — THESE REPRESENT THE COMPLETE MODEL OF THE KALIWADAS DAM WITH THE PHENOMENA ILLUSTRATED IN FIGURE 90.

VLUGT, *Waterstaatsingenieur* 1931, No. 7). The form of the adjustable measuring weir, according to the project of D. G. ROMIJN, has been determined as exactly as possible. This apparatus has replaced practically all other measuring systems such as tertiary outlet,[3] including the Cipoletti weir.

**Riverbed Improvements.** — To this category belong the provisions necessary for the protection of roads along bends scoured out by rivers and for the protection of the abutment of bridges. Hereto belong also the measures for the deepening of channels which are silting up. The desired result was usually obtained by revetments.

This has led to a large number of experiments to determine the necessary number and the correct direction and length of the revetments. The types investigated include both the ordinary fascines, consisting of wire mattresses, as well as the so-called open fascines which are formed by piling driven into the bottom and interconnected so as to form a screen.

[3] D. G. ROMIJN, Een regelbare meetoverlaat als tertiaire aftapsluis (*De Waterstaatsingenieur* 1932, No. 9).

**Special Problems.** — A number of special projects that cannot be listed under one of the previous headings have been carried out in the laboratories. We mention the following ones:

(*a*) Cavitation phenomena at outlets and inlets under high pressure or near curved parts where the water runs at high speed.

(*b*) The application of horizontal gratings.

(*c*) The pumps of the irrigation system according to Dr. W. J. VAN BLOMMESTEIN.

(*d*) The avoidance of air suction by eddies near turbine shafts.

(*e*) Determination of crosspieces for slanting gutters.

(*f*) Shaping of piles for straight and oblique impact with the current.

(*g*) Determination of coefficients of roughness, a.o. for the passage of finely divided sulphur in water through a rubber tube.

(*h*) Filling and emptying of a drydock, etc.

This is, as far as possible in a short paper, the

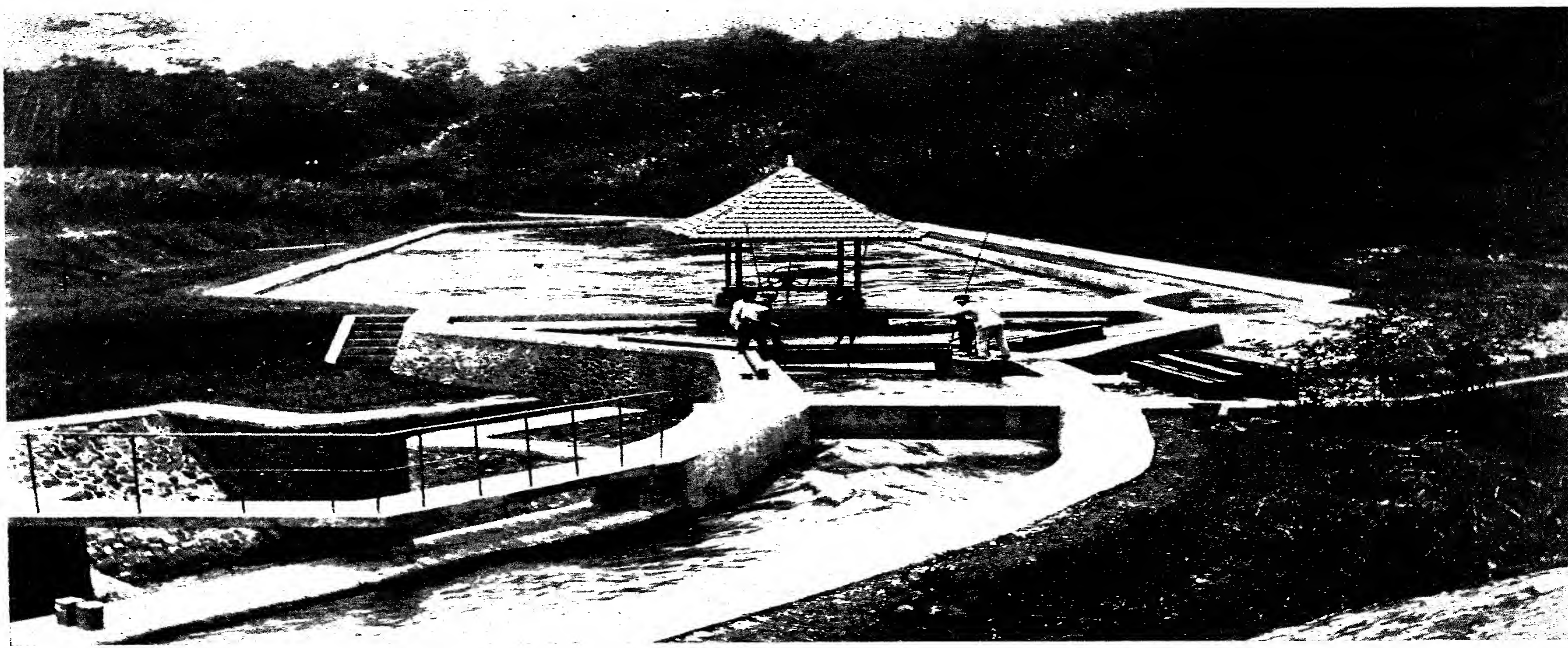


FIGURE 98. — THE OLBROEG DAM (Java), a good example of undersluicing as practiced in the Netherlands East Indies. — *Courtesy Netherlands Information Bureau, New York City.*

balance sheet of twelve and a half years of experimental research on models in the Netherlands Indies.

It is hardly astonishing that so much has been accomplished, since the hydraulic laboratory is a new tool in hydrodynamics.

Plenty remains to be done, but this can be only an incentive to further work. A history of the works that have been constructed or improved as a result of experiments with models in the last twelve and a half years is being planned for the near future.

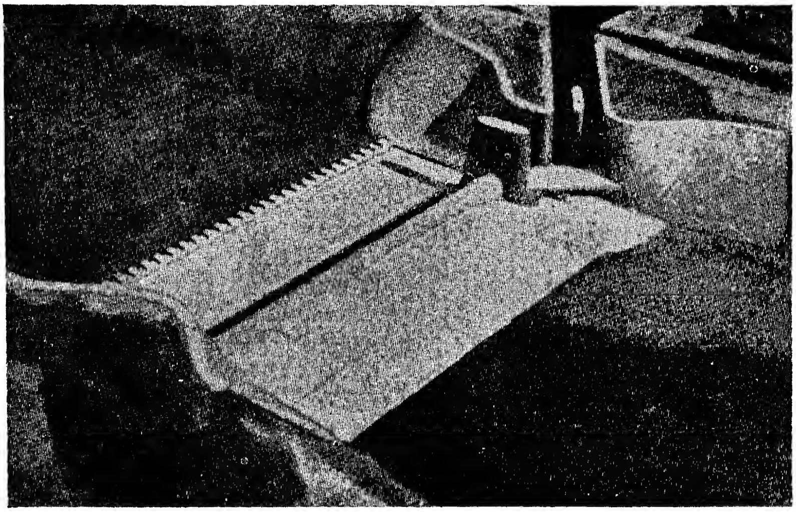


FIGURE 99. — PLATE CONSTRUCTION WITH UNDERSLUICING FOR A MODEL OF THE TEEKOENG DAM.

# MEDICAL EDUCATION IN THE NETHERLANDS INDIES

*by*

A. DE WAART, M.D.*

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In 1852 at the suggestion of Dr. W. BOSCH, at the time Chief of the Government Medical Service of the Netherlands Indies, a two-year medical training course was started at the Military Hospital at Weltevreden near Batavia. To this training school sons of better class Javanese families, knowing Malay, the language used for teaching, were admitted. It was the intention that the graduates of this training school should give medical care as so-called "doctors djawa" to the native population.

In 1856 the first non-Javanese pupils were accepted. In 1864 the teaching was extended to a three-year curriculum. It was then decided that the "doctors djawa" should work independently in the field, which decision, however, was withdrawn in 1867. Soon experience showed that supervision of the practice of the "doctors djawa" was practically impossible and shortly afterwards "doctors djawa" were again trained for independent practice. In 1875 the schedule was divided into a preparatory part consisting of two years' training and a medical part of five years' duration. The Netherlands language now became the medium of teaching. The teaching staff, originally consisting of three Army Medical Officers, including the Director, was enlarged to five functionaries, to which were also added two civilian teachers. In 1881 the preparatory training was changed to three years; in 1883 the number of military teachers was enlarged to seven; in 1886 that of the civilian teachers to three. In 1888 the "Laboratory for Pathology and Bacteriology" which was designated as the Central Medical Laboratory, and in recent years as the Eijkman Institute, was opened and the Directorship and Assistant Directorship were combined with that of the "doctors djawa" school.

In 1890 knowledge of the Dutch language became a requirement for admission. In the same

* Based on the author's account in *Geneeskundig Tijdschrift voor Nederlandsch-Indië, Feestbundel* 1936, pp. 246–257, translated by Mrs. J. A. C. FAGGINGER AUER of Belmont, Mass., abridged and annotated by Dr. I. SNAPPER. — *Cf.* also a contemporary account by C. D. DE LANGEN in *Bull. Colon. Inst. Amsterd.* 1:125–134 (1938).

year the first Out-Patient Departments were opened. Dr. H. D. ROLL became Director of the Central Medical Laboratory in 1896, and therefore at the same time the Head of the Medical School. Under his guidance the school which since 1872 had carried the name of S.T.O.V.I.A. (School for the Training of Indonesian Physicians) was greatly improved. The classrooms in the Military Hospital were enlarged. Next to this hospital a separate school was built for the housing of 200 pupils. The Out-Patients Department was transferred to this building, the wards remained in the hospital, and the Hospital localities which became vacant by the transfer of the Dispensary were used for an Obstetrical Department. Obstetrics, which had never been taught before to the "doctors djawa," who were qualified to act only as physicians and surgeons, then became a subject for both instruction and examination. This completed the training of the Indonesian physicians. The study period was extended to six years and the Director of the School was no more concurrently Director of the Central Laboratory.

Because the Military Hospital could put only ten beds at the disposal of the School in 1902, relations were established with the Central City Hospital. In 1903 a competitive entrance examination was required before entering the school. In 1908 ROLL was succeeded by Dr. J. NOORDHOEK HEGT under whose direction the school prospered even more. Danger of retrogression threatened when a report of the Board for Reorganization of the Civil Medical Service made proposals to lower the educational requirements, but thanks to HEGT's initiative, this danger was averted.

An important event relating to medical education took place in 1913, when a Committee appointed by the Government advised to found a second medical school in order to increase the yearly number of graduates.

In view of the many responsible duties which rested upon the Indonesian physician, the Committee advised also raising the educational standards both in the existing S.T.O.V.I.A. and in the newly planned medical school. The Government agreed and in 1913 the first course of the preparatory part of the new medical school, designated as the N.I.A.S. (School for Indonesian Physicians) was opened in Soerabaja. In both the S.T.O.V.I.A. and the N.I.A.S. the medical instruction was extended to seven years in order to emphasize the study of physics, chemistry, botany and biology, Dutch and German. Laboratory courses for physics, zoology, botany, histology, physiology, physiological chemistry, parasitology and pathology — besides the already existing laboratory courses in chemistry and anatomy — were organized, first for the S.T.O.V.I.A. and later for the N.I.A.S.

The staff of the S.T.O.V.I.A. was reinforced with full-time teachers for chemistry and physics and for anatomy. Gradually the S.T.O.V.I.A. became more independent of the Military Medical Service, to which in the beginning it was so closely linked. In 1913 Dr. R. LESK, once an Army surgeon, was appointed as civilian instructor in surgery, skin and venereal diseases. In 1914 C. D. DE LANGEN was appointed as full-time instructor in Internal Medicine, soon afterwards R. DE WAART as full-time instructor in histology and physiology. In the meantime the medical part of the N.I.A.S. had been opened in 1916. From 1913 onwards students of all races were admitted to both schools. Consequently, the graduates have since then been designated as "Indonesian physicians."

Proposals to build a new S.T.O.V.I.A. to be combined with the newly planned Central Medical Laboratory and with the projected Central City Hospital were accepted. Unfortunately, HEGT, the Director of the S.T.O.V.I.A., died at the end of 1915, just before the laying of the corner stone of the building complex which he had visualized so clearly (August 26, 1916). On July 5, 1920, the entire medical instruction at Batavia was transferred to these new and modern buildings. From 1924 onwards the preliminary courses in both medical schools were gradually eliminated, because they had lost their purpose since the high-school education had become general in the Netherlands East Indies. In 1926, on the 75th Anniversary of the S.T.O.V.I.A., the school counted 296 pupils.

Since 1913 when the preparatory division of the N.I.A.S. was opened in Soerabaja, this institution, of which Dr. A. E. SITSEN was Director, progressed mainly along the same lines as the S.T.O.V.I.A. However, during the first ten years of its existence this school lacked sufficient buildings and equipment. In 1923 new buildings were opened providing good classrooms for lectures on non-clinical subjects and highly satisfactory quarters for practical courses, musea, library and administration. Room was also found for the technical department of the School of Dentistry, which will be referred to later. In the same year the first native physicians graduated from the N.I.A.S. Up to April 1935, 165 Indonesian doctors completed their studies here. In 1938 conditions were very favorable. The N.I.A.S. had well-equipped laboratories, and a large teaching hospital, with dispensaries and clinics. In this year the number of pupils was 362.

The development of the S.T.O.V.I.A. and N.I.A.S. was of great importance for the social and intellectual evolution of the Netherlands East Indies and especially for the medical care of the population. Even so, these schools with their rigorous curricula and their strict supervision over the pupils had decidedly the character of medical colleges. Neither S.T.O.V.I.A. nor N.I.A.S. could be compared with the medical schools affiliated with the Universities in the Netherlands. For a long time the Indonesian Society for College Education had both for ideal and practical reasons strongly advocated the foundation of institutions of university standing. In the beginning the deficiency of the pre-college education in the Netherlands Indies seemed to form an unsurmountable barrier which would render the realization of such plans impossible. During the years 1916 and 1917 only 55 pupils in the entire Netherlands East Indies received a graduation certificate from high schools, but in 1930 and 1931 these numbers had increased to 462 and 466 respectively. This rapid development of higher education in the Netherlands Indies led to the founding of an Institute of Technology in Bandoeng in 1920, of a Law School in Batavia in 1924 and in 1925 it was decided that a fully fledged Medical School, a Medical College, was to be founded in Batavia. In 1927 the S.T.O.V.I.A. which during the years of its existence had graduated 551 Indonesian physicians was closed, whereas the N.I.A.S. continued unchanged. The famous histologist J. BOEKE who

FIGURE 100. — TREATMENT FOR WORM DISEASE IN A JAVANESE VILLAGE.

in 1913–1914 had taught anatomy at the S.T.O.V.I.A. returned temporarily to Batavia to become in 1927 the first Dean of the new Medical College. His successor was the clinician, C. D. DE LANGEN. The expectation that a sufficient number of students would register for admission to the Medical College was amply realized. The number of students increased steadily each year, so that in 1935, eight years after its foundation, 447 students were registered; in 1939 this figure had increased to 543, of whom 120 were freshmen. Among the 447 students registered in 1935 were 84 Europeans, 151 Chinese, 209 natives, 2 Japanese and 1 American. There were also 30 women students. In 1939 the school graduated 39 physicians, 11 of whom were Europeans, 15 Indonesians, 13 Chinese. Often the students and their relations had to suffer considerable financial sacrifices in order to permit the student to complete his medical school career.

In this way the level of medical education in the Netherlands East Indies has been raised to the same level as that of the Netherlands, with the same requirements for admission. The diplomas of the Medical College in Batavia entitle the licentiates not only to the full practice of medicine in the Netherlands Indies, but these licenses are after a few mere formalities also valid in the Netherlands. The Medical College in Batavia has fulfilled the expectations: it is not merely a teaching institution but also a center of scientific research.

The co-operation between the Medical College in Batavia and the N.I.A.S. in Soerabaja has always been pleasant and useful from both a scientific and an educational viewpoint. Both institutions have occasionally had to make sacrifices, forced upon them for economical reasons in times of financial distress, but they have never economized in their efforts to give the best and in their endeavor to improve where improvement was needed.

As youngest medical institution in the Netherlands East Indies the School for Indonesian Dentists (S.T.O.V.I.T.) must be mentioned. It was opened in Soerabaja in 1928, and provides a five-year vocational course. The school is headed by the Director of the N.I.A.S. and the instruction is partly in the hands of the teachers of the N.I.A.S. In addition there are three instructors in surgical dentistry. In 1933 the first licenses could be conferred. Up to July 1935, 34 Indonesian dentists had finished their studies. In the middle of 1934 there were 72 pupils, of whom 25 were women. In 1938 the enrollment was 81. This school will provide reliable dental care in many places in the Netherlands East Indies where until recently such care had been lacking.

This short review illustrates the state of development of the medical education in the Netherlands East Indies and reflects the important period of development through which this territory has passed during the last 25 years.

# EXPLORATIONS IN CELEBES

*by*

ALFRED RUSSEL WALLACE (1823–1913), Ll.D., D.C.L., O.M., F.R.S., etc.*
*Noted British Biologist*

I left Lombock on the 30th of August [1856], and reached Macassar in three days. It was with great satisfaction that I stepped on a shore which I had been vainly trying to reach since February, and where I expected to meet with so much that was new and interesting.

The coast of this part of Celebes is low and flat, lined with trees and villages so as to conceal the interior, except at occasional openings, which show a wide extent of bare and marshy rice-fields. A few hills of no great height were visible in the background; but owing to the perpetual haze over the land at this time of the year, I could nowhere discern the high central range of the peninsula, or the celebrated peak of Bontyne, at its southern extremity. In the roadstead of Macassar there was a fine 42-gun frigate, the guardship of the place, as well as a small war-steamer and three or four little cutters, used for cruising after the pirates which infest these seas. There were also a few square-rigged trading-vessels, and twenty or thirty native praus of various sizes. I brought letters of introduction to a Dutch gentleman, Mr. MESMAN, and also to a Danish shop-keeper, who could both speak English, and who promised to assist me in finding a place to stay at suitable for my pursuits. In the mean time I went to a kind of club-house, in default of any hotel in the place.

Macassar was the first Dutch town I had visited, and I found it prettier and cleaner than any I had yet seen in the East. The Dutch have some admirable local regulations. All European houses must be kept well whitewashed, and every person must, at four in the afternoon, water the road in front of his house. The streets are kept clear of refuse, and covered drains carry away all impurities into large open sewers, into which the tide is admitted at high-water and allowed to flow out when it has ebbed, carrying all the sewage with it into the sea. The town consists chiefly of one long, narrow street, along the seaside, devoted to business, and principally occupied by the Dutch and Chinese merchants' offices and warehouses, and the native shops or bazars. This extends northward for more than a mile, gradually merging into native houses, often of a most miserable description, but made to have a neat appearance by being all built up exactly to the straight line of the street, and being generally backed by fruit-trees. This street is usually thronged with a native population of Bugis and Macassar men, who wear cotton trowsers about twelve inches long, covering only from

* Reprinted from the author's "The Malay Archipelago", pp. 219–291, 1869 (New York: Harper & Brothers).

the hip to half-way down the thigh, and the universal Malay sarong, of gay checked colors, worn round the waist or across the shoulders in a variety of ways. Parallel to this street run two short ones, which form the old Dutch town, and are inclosed by gates. These consist of private houses, and at their southern end is the fort, the church, and a road at right angles to the beach, containing the houses of the Governor and of the principal officials. Beyond the fort again, along the beach, is another long street of native huts and many country-houses of the tradesmen and merchants. All around extend the flat rice-fields, now bare and dry and forbidding, covered with dusty stubble and weeds. A few months back these were a mass of verdure, and their barren appearance at this season offered a striking contrast to the perpetual crops on the same kind of country in Lombock and Bali, where the seasons are exactly similar, but where an elaborate system of irrigation produces the effect of a perpetual spring.

The day after my arrival I paid a visit of ceremony to the Governor, accompanied by my friend the Danish merchant, who spoke excellent English. His excellency was very polite, and offered me every facility for travelling about the country and prosecuting my researches in natural history. We conversed in French, which all Dutch officials speak very well.

Finding it very inconvenient and expensive to stay in the town, I removed at the end of a week to a little bamboo house, kindly offered me by Mr. MESMAN. It was situated about two miles away, on a small coffee plantation and farm, and about a mile beyond Mr. M.'s own country-house. It consisted of two rooms raised about seven feet above the ground, the lower part being partly open (and serving excellently to skin birds in), and partly used as a granary for rice. There was a kitchen and other out-houses, and several cottages near were occupied by men in Mr. M.'s employ.

After being settled a few days in my new house, I found that no collections could be made without going much farther into the country. The rice-fields for some miles round resembled English stubbles late in autumn, and were almost as unproductive of bird or insect life. There were several native villages scattered about, so embosomed in fruit-trees that at a distance they looked like clumps or patches of forest. These were my only collecting-places, but they produced a very limited number of species, and were soon exhausted. Before I could move to any more promising district it was necessary to obtain permission from the Rajah of Goa, whose territories approach to within two miles of the town of Macassar. I therefore presented myself at the Governor's office and requested a letter to the Rajah, to claim his protection, and permission to travel in his territories whenever I might wish to do so. This was immediately granted, and a special messenger was sent with me to carry the letter.

My friend Mr. MESMAN kindly lent me a horse, and accompanied me on my visit to the Rajah, with whom he was great friends. We found his Majesty seated out of doors, watching the erection of a new house. He was naked from the waist up, wearing only the usual short trowsers and sarong. Two chairs were brought out for us, but all the chiefs and other natives were seated on the ground. The messenger, squatting down at the Rajah's feet, produced the letter, which was sewn up in a covering of yellow silk. It was handed to one of the chief officers, who ripped it open and returned it to the Rajah, who read it, and then showed it to Mr. M., who both speaks and reads the Macassar language fluently, and who explained fully what I required. Permission was immediately granted me to go where I liked in the territories of Goa, but the Rajah desired that, should I wish to stay any time at a place, I would first give him notice, in order that he might send some one to see that no injury was done me. Some wine was then brought us, and afterward some detestable coffee and wretched sweetmeats, for it is a fact that I have never tasted good coffee where people grow it themselves.

Although this was the height of the dry season, and there was a fine wind all day, it was by no means a healthy time of year. My boy ALI had hardly been a day on shore when he was attacked by fever, which put me to great inconvenience, as at the house where I was staying nothing could be obtained but at meal-times. After having cured ALI, and with much difficulty got another servant to cook for me, I was no sooner settled at my country abode than the latter was attacked with the same disease, and, having a wife in the town, left me. Hardly was he gone than I fell ill myself, with strong intermittent fever every other day. In about a week I got over it by a liberal use of quinine, when scarcely was I on my legs than ALI again became worse than ever. His fever attacked him daily, but early in the morning he was pretty well, and then managed to cook me enough for the day. In a week I cured him, and also succeeded in getting another boy who could cook and shoot, and had no objection to go into the interior. His name was BADEROON; and as he was unmarried and had been used to a roving life, having been several voyages to North Australia to catch trepang or "bêche de mer," I was in hopes of being able to keep him. I also got hold of a little impudent rascal of twelve or fourteen, who could speak some Malay, to carry my gun or insect-net and make himself generally useful. ALI had by this time become a pretty good bird-skinner, so that I was fairly supplied with servants.

I made many excursions into the country in search of a good station for collecting birds and insects. Some of the villages a few miles inland are scattered about in woody ground which has once been virgin forest, but of which the constituent trees have been for the most part replaced by fruit-trees, and particularly by the large palm (*Arenga saccharifera*), from which wine and sugar are made, and which also produces a coarse black fibre used for cordage. That necessary of life, the bamboo, has also been abundantly planted. In such places I found a good many birds, among which were the fine cream-colored pigeon (*Carpophaga luctuosa*) and the rare blue-headed roller (*Coracias temmincki*), which has a most discordant voice, and generally goes in pairs, flying from tree to tree, and exhibiting while at rest that all-in-a-heap appearance and jerking motion of the head and tail which are so characteristic of the great fissirostral group to which it belongs. From this habit alone, the kingfishers, bee-eaters, rollers, trogons, and South American puff-birds might be grouped together by a person who had observed them in a

state of nature, but who had never had an opportunity of examining their form and structure in detail. Thousands of crows, rather smaller than our rook, keep up a constant cawing in these plantations; the curious wood-swallows (*Artami*), which closely resemble swallows in their habits and flight, but differ much in form and structure, twitter from the treetops; while a lyre-tailed drongo-shrike, with brilliant black plumage and milk-white eyes, continually deceives the naturalist by the variety of its unmelodious notes.

In the more shady parts butterflies were tolerably abundant; the most common being species of *Euplœa* and *Danais*, which frequent gardens and shrubberies, and, owing to their weak flight, are easily captured. A beautiful pale blue-and-black butterfly, which flutters along near the ground among the thickets, and settles occasionally upon flowers, was one of the most striking; and scarcely less so was one with a rich orange band on a blackish ground: these both belong to the *Pieridæ*, the group that contains our common white butterflies, although differing so much from them in appearance. Both were quite new to European naturalists.[1] Now and then I extended my walks some miles farther to the only patch of true forest I could find, accompanied by my two boys with guns and insect-net. We used to start early, taking our breakfast with us, and eating it wherever we could find shade and water. At such times my Macassar boys would put a minute fragment of rice and meat or fish on a leaf, and lay it on a stone or stump as an offering to the deity of the spot; for, though nominal Mohammedans, the Macassar people retain many pagan superstitions, and are but lax in their religious observances. Pork, it is true, they hold in abhorrence, but will not refuse wine when offered them, and consume immense quantities of "sagueir," or palm-wine, which is about as intoxicating as ordinary beer or cider. When well made, it is a very refreshing drink, and we often took a draught at some of the little sheds dignified by the name of bazars, which are scattered about the country wherever there is any traffic.

One day Mr. MESMAN told me of a larger piece of forest where he sometimes went to shoot deer, but he assured me it was much further off, and that there were no birds. However, I resolved to explore it, and the next morning at five o'clock we started, carrying our breakfast and some other provisions with us, and intending to stay the night at a house on the borders of the wood. To my surprise, two hours' hard walking brought us to this house, where we obtained permission to pass the night. We then walked on, ALI and BADEROON with a gun each, BASO carrying our provisions and my insect-box, while I took only my net and collecting-bottle, and determined to devote myself wholly to the insects. Scarcely had I entered the forest when I found some beautiful little green and gold speckled weevils, allied to the genus *Pachyrhynchus*, a group which is almost confined to the Philippine Islands, and is quite unknown in Borneo, Java, or Malacca. The road was shady, and apparently much trodden by horses and cattle, and I quickly obtained some butterflies I had not before met with. Soon a couple of reports were heard, and, coming up to my boys, I found they had shot two specimens of one of the finest of known cuckoos (*Phœnicophaus callirhynchus*). This bird derives its name from its large bill being colored of a brilliant yellow, red, and black, in about equal proportions. The tail is exceedingly long, and of a fine metallic purple, while the plumage of the body is light coffee-brown. It is one of the characteristic birds of the island of Celebes, to which it is confined.

After sauntering along for a couple of hours we reached a small river, so deep that horses could only cross it by swimming, so we had to turn back; but as we were getting hungry, and the water of the almost stagnant river was too muddy to drink, we went toward a house a few hundred yards off. In the plantation we saw a small raised hut, which we thought would do well for us to breakfast in, so I entered, and found inside a young woman with an infant. She handed me a jug of water, but looked very much frightened. However, I sat down on the door-step and asked for the provisions. In handing them up, BADEROON saw the infant, and started back as if he had seen a serpent. It then immediately struck me that this was a hut in which, as among the Dyaks of Borneo and many other savage tribes, the women are secluded for some time after the birth of their child, and that we did very wrong to enter it; so we walked off and asked permission to eat our breakfast in the family mansion close at hand, which was of course granted. While I ate, three men, two women, and four children watched every motion, and never took eyes off me till I had finished.

On our way back in the heat of the day I had the good-fortune to capture three specimens of a fine *Ornithoptera*, the largest, the most perfect, and the most beautiful of butterflies. I trembled with excitement as I took the first out of my net and found it to be in perfect condition. The ground color of this superb insect was a rich shining bronzy black, the lower wings delicately grained with white, and bordered by a row of large spots of the most brilliant satiny yellow. The body was marked with shaded spots of white, yellow, and fiery orange, while the head and thorax were intense black. On the under side the lower wings were satiny white, with the marginal spots half black and half yellow. I gazed upon my prize with extreme interest, as I at first thought it was quite a new species. It proved, however, to be a variety of *Ornithoptera remus*, one of the rarest and most remarkable species of this highly esteemed group. I also obtained several other new and pretty butterflies. When we arrived at our lodging-house, being particularly anxious about my insect treasures, I suspended the box from a bamboo on which I could detect no sign of ants, and then began skinning some of my birds. During my work I often glanced at my precious box to see that no intruders had arrived, till after a longer spell of work than usual I looked again, and saw to my horror that a column of small red ants were descending the string and entering the box. They were already busy at work at the bodies of my treasures, and another half-hour would have seen my whole day's collection destroyed. As it was, I had to take every insect out, clean them thoroughly as well as the box, and then seek for a place of safety for them. As the only effectual one, I begged a plate and a basin from my host, filled the former with water, and standing the

[1] The former has been named *Eronia tritæa*, the latter *Tachyris ithome*.

latter in it, placed my box on the top, and then felt secure for the night; a few inches of clean water or oil being the only barrier these terrible pests are not able to pass.

On returning home to Mamâjam (as my house was called) I had a slight return of intermittent fever, which kept me some days in-doors. As soon as I was well I again went to Goa, accompanied by Mr. MESMAN, to beg the Rajah's assistance in getting a small house built for me near the forest. We found him at a cock-fight in a shed near his palace, which however he immediately left to receive us, and walked with us up an inclined plane of boards, which serves for stairs, to his house. This was large, well-built, and lofty, with bamboo floor and glass windows. The greater part of it seemed to be one large hall divided by the supporting posts. Near a window sat the Queen, squatting on a rough wooden armchair, chewing the everlasting sirih and betel-nut, while a brass spittoon by her side and a sirih-box in front were ready to administer to her wants. The Rajah seated himself opposite to her in a similar chair, and a similar spittoon and sirih-box were held by a little boy squatting at his side. Two other chairs were brought for us. Several young women, some the Rajah's daughters, others slaves, were standing about; a few were working at frames making sarongs, but most of them were idle . . .

The only thing that excited some degree of admiration was the quiet and dignified manner of the Rajah, and the great respect always paid to him. None can stand erect in his presence; and when he sits on a chair, all present (Europeans of course excepted) squat upon the ground. The highest seat is literally, with these people, the place of honor and the sign of rank. So unbending are the rules in this respect, that when an English carriage which the Rajah of Lombock had sent for arrived, it was found impossible to use it because the driver's seat was the highest, and it had to be kept as a show in its coachhouse. On being told the object of my visit, the Rajah at once said that he would order a house to be emptied for me, which would be much better than building one, as that would take a good deal of time. Bad coffee and sweetmeats were given us as before.

Two days afterward I called on the Rajah to ask him to send a guide with me to show me the house I was to occupy. He immediately ordered a man to be sent for, gave him instructions, and in a few minutes we were on our way. My conductor could speak no Malay, so we walked on in silence for an hour, when we turned into a pretty good house, and I was asked to sit down. The head-man of the district lived here, and in about half an hour we started again, and another hour's walk brought us to the village where I was to be lodged. We went to the residence of the village chief, who conversed with my conductor for some time. Getting tired, I asked to be shown the house that was prepared for me, but the only reply I could get was, "Wait a little," and the parties went on talking as before. So I told them I could not wait, as I wanted to see the house, and then to go shooting in the forest. This seemed to puzzle them, and at length, in answer to questions very poorly explained by one or two by-standers who knew a little Malay, it came out that no house was ready, and no one seemed to have the least idea where to get one. As I did not want to trouble the Rajah any more, I thought it best to try to frighten them a little; so I told them that if they did not immediately find me a house as the Rajah had ordered, I should go back and complain to him, but that if

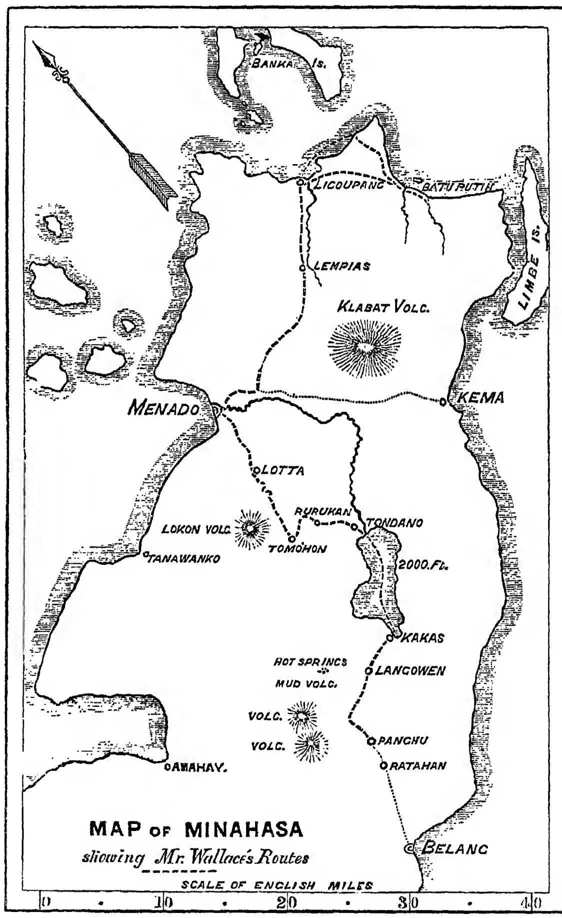


FIGURE 101. — Mr. WALLACE's routes in the Minahassa.

a house was found me I would pay for the use of it. This had the desired effect, and one of the head-men of the village asked me to go with him and look for a house. He showed me one or two of the most miserable and ruinous description, which I at once rejected, saying, "I must have a good one, and near to the forest." The next he showed me suited very well, so I told him to see that it was emptied the next day, for that the day after I should come and occupy it.

On the day mentioned, as I was not quite

ready to go, I sent my two Macassar boys with brooms to sweep out the house thoroughly. They returned in the evening and told me that when they got there the house was inhabited, and not a single article removed. However, on hearing they had come to clean and take possession, the occupants made a move, but with a good deal of grumbling, which made me feel rather uneasy as to how the people generally might take my intrusion into their village. The next morning we took our baggage on three pack-horses, and, after a few breakdowns, arrived about noon at our destination.

After getting all my things set straight, and having made a hasty meal, I determined if possible to make friends with the people. I therefore sent for the owner of the house and as many of his acquaintances as liked to come, to have a "bitchára," or talk. When they were all seated, I gave them a little tobacco all round, and having my boy BADEROON for interpreter, tried to explain to them why I came there; that I was very sorry to turn them out of the house, but that the Rajah had ordered it rather than build a new one, which was what I had asked for, and then placed five silver rupees in the owner's hand as one month's rent. I then assured them that my being there would be a benefit to them, as I should buy their eggs and fowls and fruit; and if their children would bring me shells and insects, of which I showed them specimens, they also might earn a good many coppers. After all this had been fully explained to them, with a long talk and discussion between every sentence, I could see that I had made a favorable impression; and that very afternoon, as if to test my promise to buy even miserable little snail-shells, a dozen children came one after another, bringing me a few specimens each of a small Helix, for which they duly received "coppers," and went away amazed but rejoicing.

A few days' exploration made me well acquainted with the surrounding country. I was a long way from the road in the forest which I had first visited, and for some distance round my house were old clearings and cottages. I found a few good butterflies, but beetles were very scarce, and even rotten timber and newly-felled trees (generally so productive) here produced scarcely any thing. This convinced me that there was not a sufficient extent of forest in the neighborhood to make the place worth staying at long, but it was too late now to think of going further, as in about a month the wet season would begin; so I resolved to stay here and get what was to be had. Unfortunately, after a few days I became ill with a low fever, which produced excessive lassitude and disinclination to all exertion. In vain I endeavored to shake it off; all I could do was to stroll quietly each day for an hour about the gardens near, and to the well, where some good insects were occasionally to be found, and the rest of the day to wait quietly at home, and receive what beetles and shells my little corps of collectors brought me daily. I imputed my illness chiefly to the water, which was procured from shallow wells, around which there was almost always a stagnant puddle in which the buffaloes wallowed. Close to my house was an inclosed mud-hole where three buffaloes were shut up every night, and the effluvia from which freely entered through the open bamboo floor. My Malay boy ALI was affected with the same illness; and as he was my chief bird-skinner, I got on but slowly with my collections.

The occupations and mode of life of the villagers differed but little from those of all other Malay races. The time of the women was almost wholly occupied in pounding and cleaning rice for daily use, in bringing home firewood and water, and in cleaning, dyeing, spinning, and weaving the native cotton into sarongs. The weaving is done in the simplest kind of frame stretched on the floor, and is a very slow and tedious process. To form the checked pattern in common use, each patch of colored threads has to be pulled up separately by hand and the shuttle passed between them, so that about an inch a day is the usual progress in stuff a yard and a half wide. The men cultivate a little sirih (the pungent pepper leaf used for chewing with betel-nut) and a few vegetables, and once a year rudely plow a small patch of ground with their buffaloes and plant rice, which then requires little attention till harvest-time. Now and then they have to see to the repairs of their houses, and make mats, baskets, or other domestic utensils, but a large part of their time is passed in idleness.

Not a single person in the village could speak more than a few words of Malay, and hardly any of the people appeared to have seen a European before. One most disagreeable result of this was that I excited terror alike in man and beast. Wherever I went, dogs barked, children screamed, women ran away, and men stared as though I were some strange and terrible cannibal monster. Even the pack-horses on the roads and paths would start aside when I appeared and rush into the jungle; and as to those horrid, ugly brutes, the buffaloes, they could never be approached by me not for fear of my own, but of others' safety. They would first stick out their necks and stare at me, and then on a nearer view break loose from their halters or tethers, and rush away helter-skelter as if a demon were after them, without any regard for what might be in their way. Whenever I met buffaloes carrying packs along a pathway, or being driven home to the village, I had to turn aside into the jungle and hide myself till they had passed, to avoid a catastrophe which would increase the dislike with which I was already regarded. Every day about noon the buffaloes were brought into the village, and were tethered in the shade around the houses; and then I had to creep about like a thief by back ways, for no one could tell what mischief they might do to children and houses were I to walk among them. If I came suddenly upon a well where women were drawing water or children bathing, a sudden flight was the certain result; which things occurring day after day, were very unpleasant to a person who does not like to be disliked, and who had never been accustomed to be treated as an ogre.

About the middle of November, finding my health no better, and insects, birds, and shells all very scarce, I determined to return to Manájam and pack up my collections before the heavy rains commenced. The wind had already begun to blow from the west, and many signs indicated that the rainy season might set in earlier than usual; and then every thing becomes very damp, and it is almost impossible to dry collections properly. My kind friend Mr. MESMAN again lent me his pack-horses, and with the assistance of a few men to carry my birds and insects,

which I did not like to trust on horses' backs, we got every thing home safe. Few can imagine the luxury it was to stretch myself on a sofa, and to take my supper comfortably at table seated in my easy bamboo chair, after having for five weeks taken all my meals uncomfortably on the floor. Such things are trifles in health, but when the body is weakened by disease the habits of a lifetime can not be so easily set aside.

My house, like all bamboo structures in this country, was a leaning one, the strong westerly winds of the wet season having set all its posts out of the perpendicular to such a degree as to make me think it might some day possibly go over altogether. It is a remarkable thing that the natives of Celebes have not discovered the use of diagonal struts in strengthening buildings. I doubt if there is a native house in the country two years old and at all exposed to the wind, which stands upright; and no wonder, as they merely consist of posts and joists all placed upright or horizontal, and fastened rudely together with rattans. They may be seen in every stage of the process of tumbling down, from the first slight inclination, to such a dangerous slope that it becomes a notice to quit to the occupiers.

The mechanical geniuses of the country have only discovered two ways of remedying the evil. One is, after it has commenced, to tie the house to a post in the ground on the windward side by a rattan or bamboo cable. The other is a preventive, but how they ever found it out and did not discover the true way is a mystery. This plan is to build the house in the usual way, but instead of having all the principal supports of straight posts, to have two or three of them chosen as crooked as possible. I had often noticed these crooked posts in houses, but imputed it to the scarcity of good straight timber, till one day I met some men carrying home a post shaped something like a dog's hind leg, and inquired of my native boy what they were going to do with such a piece of wood. "To make a post for a house," said he. "But why don't they get a straight one, there are plenty here?" said I. "Oh," replied he, "they prefer some like that in a house, because then it won't fall," evidently imputing the effect to some occult property of crooked timber. A little consideration and a diagram will, however, show that the effect imputed to the crooked post may be really produced by it. A true square changes its figure readily into a rhomboid or oblique figure; but when one or two of the uprights are bent or sloping, and placed so as to oppose each other, the effect of a strut is produced, though in a rude and clumsy manner.

Just before I had left Mamájam the people had sown a considerable quantity of maize, which appears above ground in two or three days, and in favorable seasons ripens in less than two months. Owing to a week's premature rains the ground was all flooded when I returned, and the plants just coming into ear, were yellow and dead. Not a grain would be obtained by the whole village, but luckily it is only a luxury, not a necessary of life. The rain was the signal for plowing to begin, in order to sow rice on all the flat lands between us and the town. The plow used is a rude wooden instrument th a very short handle, a tolerably well-shaped coulter, and the point formed of a piece of hard palmwood fastened in with wedges. One or two buffaloes draw it at a very slow pace. The seed is sown broadcast, and a rude wooden harrow is used to smooth the surface.

By the beginning of December the regular wet season had set in. Westerly winds and driving rains sometimes continued for days together; the fields for miles around were under water, and the ducks and buffaloes enjoyed themselves amazingly. All along the road to Macassar plowing was daily going on in the mud and water, through which the wooden plow easily makes its way, the plowman holding the plow-handle with one hand, while a long bamboo in the other serves to guide the buffaloes. These animals require an immense deal of driving to get them on at all; a continual shower of exclamations is kept up at them, and "oh! ah! gee! ugh!" are to be heard in various keys and in an uninterrupted succession all day long. At night we were favored with a different kind of concert. The dry ground around my house had become a marsh tenanted by frogs, who kept up a most incredible noise from dusk to dawn. They were somewhat musical too, having a deep vibrating note which at times closely resembles the tuning of two or three bassviols in an orchestra. In Malacca and Borneo I had heard no such sounds as these, which indicates that the frogs, like most of the animals of Celebes, are of species peculiar to it.

My kind friend and landlord, Mr. MESMAN, was a good specimen of the Macassar-born Dutchman. He was about thirty-five years of age, had a large family, and lived in a spacious house near the town, situated in the midst of a grove of fruit-trees, and surrounded by a perfect labyrinth of offices, stables, and native cottages, occupied by his numerous servants, slaves, or dependents. He usually rose before the sun, and after a cup of coffee looked after his servants, horses, and dogs till seven, when a substantial breakfast of rice and meat was ready in a cool veranda. Putting on a clean white linen suit, he then drove to town in his buggy, where he had an office, with two or three Chinese clerks, who looked after his affairs. His business was that of a coffee and opium merchant. He had a coffee estate at Bontyne, and a small prau which traded to the Eastern islands, near New Guinea, for mother-of-pearl and tortoise-shell. About one he would return home, have coffee and cake or fried plantain, first changing his dress for a colored cotton shirt and trowsers and bare feet, and then take a siesta with a book. About four, after a cup of tea, he would walk round his premises, and generally stroll down to Mamájam to pay me a visit and look after his farm.

This consisted of a coffee-plantation and an orchard of fruit-trees, a dozen horses and a score of cattle, with a small village of Timorese slaves and Macassar servants. One family looked after the cattle and supplied the house with milk, bringing me also a large glassful every morning, one of my greatest luxuries. Others had charge of the horses, which were brought in every afternoon and fed with cut grass. Others had to cut grass for their master's horses at Macassar — not a very easy task in the dry season, when all the country looks like baked mud, or in the rainy season, when miles in every direction are flooded. How they managed it was a mystery to me, but they know grass must be had, and they get it. One lame woman had charge of a flock of ducks. Twice a day she took them out to feed in the marshy places, let them waddle and gobble for an hour or two, and then drove them back and

shut them up in a small dark shed to digest their meal, whence they gave forth occasionally a melancholy quack. Every night a watch was set, principally for the sake of the horses, the people of Goa, only two miles off, being notorious thieves, and horses offering the easiest and most valuable spoil. This enabled me to sleep in security, although many people in Macassar thought I was running a great risk, living alone in such a solitary place and with such bad neighbors.

My house was surrounded by a kind of straggling hedge of roses, jessamines, and other flowers, and every morning one of the women gathered a basketful of the blossoms for Mr. MESMAN's family. I generally took a couple for my own breakfast-table, and the supply never failed during my stay, and I suppose never does. Almost every Sunday Mr. M. made a shooting excursion with his eldest son, a lad of fifteen, and I generally accompanied him; for though the Dutch are Protestants, they do not observe Sunday in the rigid manner practiced in England and English colonies. The Governor of the place has his public reception every Sunday evening, when card-playing is the regular amusement.

On December 13th I went on board a prau bound for the Aru Islands, a journey which will be described in the latter part of this work.

On my return, after seven months' absence, I visited another district to the north of Macassar, which will form the subject of the next chapter.

I reached Macassar again on the 11th of July [1857], and established myself in my old quarters at Mamâjam, to sort, arrange, clean, and pack up my Aru collections. This occupied me a month; and having shipped them off for Singapore, had my guns repaired, and received a new one from England, together with a stock of pins, arsenic, and other collecting requisites, I began to feel eager for work again, and had to consider where I should spend my time till the end of the year. I had left Macassar, seven months before, a flooded marsh, being plowed up for the rice-sowing. The rains had continued for five months, yet now all the rice was cut, and dry and dusty stubbles covered the country just as when I had first arrived there.

After much inquiry I determined to visit the district of Máros, about thirty miles north of Macassar, where Mr. JACOB MESMAN, a brother of my friend, resided, who had kindly offered to find me house-room and give me assistance should I feel inclined to visit him. I accordingly obtained a pass from the Resident, and having hired a boat, set off one evening for Máros. My boy ALI was so ill with fever that I was obliged to leave him in the hospital, under the care of my friend the German doctor, and I had to make shift with two new servants utterly ignorant of every thing. We coasted along during the night, and at daybreak entered the Máros River, and by three in the afternoon reached the village. I immediately visited the Assistant Resident, and applied for ten men to carry my baggage, and a horse for myself. These were promised to be ready that night, so that I could start as soon as I liked in the morning. After having taken a cup of tea I took my leave, and slept in the boat. Some of the men came at night as promised, but others did not arrive till the next morning. It took some time to divide my baggage fairly among them, as they all wanted to shirk the heavy boxes, and would seize hold of some light article and march off with it, till made to come back and wait till the whole had been fairly apportioned. At length about eight o'clock all was arranged, and we started for our walk to Mr. M.'s farm.

The country was at first a uniform plain of burnt-up rice-grounds, but at a few miles' distance precipitous hills appeared, backed by the lofty central range of the peninsula. Toward these our path lay, and after having gone six or eight miles the hills began to advance into the plain right and left of us, and the ground became pierced here and there with blocks and pillars of limestone rock, while a few abrupt conical hills and peaks rose like islands. Passing over an elevated tract forming the shoulder of one of the hills, a picturesque scene lay before us. We looked down into a little valley almost entirely surrounded by mountains, rising abruptly in huge precipices, and forming a succession of knolls and peaks and domes of the most varied and fantastic shapes. In the very centre of the valley was a large bamboo house, while scattered around were a dozen cottages of the same material.

I was kindly received by Mr. JACOB MESMAN in an airy saloon detached from the house, and entirely built of bamboo and thatched with grass. After breakfast he took me to his foreman's house, about a hundred yards off, half of which was given up to me till I should decide where to have a cottage built for my own use. I soon found that this spot was too much exposed to the wind and dust, which rendered it very difficult to work with papers or insects. It was also dreadfully hot in the afternoon, and after a few days I got a sharp attack of fever, which determined me to move. I accordingly fixed on a place about a mile off, at the foot of a forest-covered hill, where in a few days Mr. M. built for me a nice little house, consisting of a good-sized inclosed veranda or open room, and a small inner sleeping-room, with a little cook-house outside. As soon as it was finished I moved into it, and found the change most agreeable.

The forest which surrounded me was open, and free from underwood, consisting of large trees, widely scattered with a great quantity of palm-trees (*Arenga saccharifera*), from which palm wine and sugar are made. There were also great numbers of a wild jack-fruit tree (*Artocarpus*), which bore abundance of large reticulated fruit, serving as an excellent vegetable. The ground was as thickly covered with dry leaves as it is in an English wood in November; the little rocky streams were all dry, and scarcely a drop of water or even a damp place was anywhere to be seen. About fifty yards below my house, at the foot of the hill, was a deep hole in a watercourse, where good water was to be had, and where I went daily to bathe, by having buckets of water taken out and pouring it over my body.

My host Mr. M. enjoyed a thoroughly country life, depending almost entirely on his gun and dogs to supply his table. Wild pigs of large size were very plentiful, and he generally got one or two a week, besides deer occasionally, and abundance of jungle-fowl, hornbills, and great fruit-pigeons. His buffaloes supplied plenty of milk, from which he made his own butter; he grew his own rice and coffee, and had ducks, fowls, and their eggs in profusion. His palm-trees supplied him all the year round with "sagueir," which takes the place of beer, and the sugar made from them is an excellent sweetmeat. All the fine tropical vegetables and fruits were abundant in their season, and his cigars were made from tobacco of his own raising. He kindly sent me a bamboo of buffalo-milk every morning; it was as thick as cream, and required diluting with water to keep it fluid during the day. It mixes very well with tea and coffee, although it has a slight peculiar flavor, which after a time is not disagreeable. I also got as much sweet "sagueir" as I liked to drink, and Mr. M. always sent me a piece of each pig he killed, which with fowls, eggs, and the birds we shot ourselves, and buffalo beef about once a fortnight, kept my larder sufficiently well supplied.

Every bit of flat land was cleared and used as rice-fields, and on the lower slopes of many of the hills tobacco and vegetables were grown. Most of the slopes are covered with huge blocks of rock, very fatiguing to scramble over, while a number of the hills are so precipitous as to be quite inaccessible. These circumstances, combined with the excessive drought, were very unfavorable for my pursuits. Birds were scarce, and I got but few new to me. Insects were tolerably plentiful, but unequal. Beetles, usually so numerous and interesting were exceedingly scarce, some of the families being quite absent, and others only represented by very minute species. The flies and bees, on the other hand, were abundant, and of these I daily obtained new and interesting species. The rare and beautiful butterflies of Celebes were the chief object of my search, and I found many species altogether new to me, but they were generally so active and shy as to render their capture a matter of great difficulty. Almost the only good place for them was in the dry beds of the streams in the forest, where, at damp places, muddy pools, or even on the dry rocks, all sorts of insects could be found. In these rocky forests dwell some of the finest butterflies in the world. Three species of *Ornithoptera*, measuring seven or eight inches across the wings, and beautifully marked with spots or masses of

satiny yellow on a black ground, wheel through the thickets with a strong sailing flight. About the damp places are swarms of the beautiful blue-banded *Papilios, miletus* and *telephus*, the superb golden-green *P. macedon*, and the rare little swallowtail *Papilio rhesus*, of all of which, though very active, I succeeded in capturing fine series of specimens.

I have rarely enjoyed myself more than during my residence here. As I sat taking my coffee at six in the morning, rare birds would often be seen on some tree close by, when I would hastily sally out in my slippers, and perhaps secure a prize I had been seeking after for weeks. The great hornbills of Celebes (*Buceros cassidix*) would often come with loud-flapping wings and perch upon a lofty tree just in front of me; and the black baboon-monkeys (*Cynopithecus nigrescens*) often stared down in astonishment at such an intrusion into their domains; while at night herds of wild pigs roamed about the house, devouring refuse, and obliging us to put away every thing eatable or breakable from our little cooking-house. A few minutes' search on the fallen trees around my house at sunrise and sunset would often produce me more beetles than I would meet with in a day's collecting, and odd moments could be made valuable, which when living in villages or at a distance from the forest are inevitably wasted. Where the sugar-palms were dripping with sap flies congregated in immense numbers, and it was by spending half an hour at these when I had the time to spare that I obtained the finest and most remarkable collection of this group of insects that I have ever made.

Then what delightful hours I passed wandering up and down the dry river-courses, full of water-holes and rocks and fallen trees, and overshadowed by magnificent vegetation! I soon got to know every hole and rock and stump, and came up to each with cautious step and bated breath to see what treasures it would produce. At one place I would find a little crowd of the rare butterfly (*Tachyris zarinda*), which would rise up at my approach, and display their vivid orange and cinnabar-red wings, while among them would flutter a few of the fine blue-banded *Papilios*. Where leafy branches hung over the gully, I might expect to find a grand *Ornithoptera* at rest, and an easy prey. At certain rotten trunks I was sure to get the curious little tiger-beetle (*Therates flavilabris*). In the denser thickets I would capture the small metallic blue butterflies (*Amblypodia*) sitting on the leaves, as well as some rare and beautiful leaf-beetles of the families *Hispidæ* and *Chrysomelidæ*.

I found that the rotten jack-fruits were very attractive to many beetles, and used to split them partly open and lay them about in the forest near my house to rot. A morning's search at these often produced me a score of species — *Staphylinidæ, Nitidulidæ, Onthophagi*, and minute *Carabidæ* being the most abundant. Now and then the "sagueir" makers brought me a fine rosechafer (*Sternoplus schaumii*) which they found licking up the sweet sap. Almost the only new birds I met with for some time were a handsome ground-thrush (*Pitta celebensis*), and a beautiful violet-crowned dove (*Ptilonopus celebensis*), both very similar to birds I had recently obtained at Aru, but of distinct species.

About the latter part of September a heavy shower of rain fell, admonishing us that we might soon expect wet weather, much to the advantage of the baked-up country. I therefore determined to pay a visit to the falls of the Máros River, situated at the point where it issues from the mountains — a spot often visited by travellers, and considered very beautiful. Mr. M. lent me a horse, and I obtained a guide from a neighboring village; and taking one of my men with me, we started at six in the morning, and after a ride of two hours over the flat rice fields skirting the mountains which rose in grand precipices on our left, we reached the river about half-way between Máros and the falls, and thence had a good bridle-road to our destination, which we reached in another hour. The hills had closed in round us as we advanced; and when we reached a ruinous shed which had been erected for the accommodation of visitors, we found ourselves in a flat-bottomed valley about a quarter of a mile wide, bounded by precipitous and often overhanging limestone rocks. So far the ground had been cultivated, but it now became covered with bushes and large scattered trees.

As soon as my scanty baggage had arrived and was duly deposited in the shed, I started off alone for the fall, which was about a quarter of a mile further on. The river is here about twenty yards wide, and issues from a chasm between two vertical walls of limestone over a rounded mass of basaltic rock about forty feet high, forming two curves separated by a slight ledge. The water spreads beautifully over this surface in a thin sheet of foam, which curls and eddies in a succession of concentric cones till it falls into a fine deep pool below. Close to the very edge of the fall a narrow and very rugged path leads to the river above, and thence continues close under the precipice along the water's edge, or sometimes in the water, for a few hundred yards, after which the rocks recede a little, and leave a wooded bank on one side, along which the path is continued, till in about half a mile a second and smaller fall is reached. Here the river seems to issue from a cavern, the rocks having fallen from above so as to block up the channel and bar further progress. The fall itself can only be reached by a path which ascends behind a huge slice of rock which has partly fallen away from the mountain, leaving a space two or three feet wide, but disclosing a dark chasm descending into the bowels of the mountain, and which, having visited several such, I had no great curiosity to explore.

Crossing the stream a little below the upper fall, the path ascends a steep slope for about five hundred feet, and passing through a gap enters a narrow valley, shut in by walls of rock absolutely perpendicular and of great height. Half a mile further this valley turns abruptly to the right, and becomes a mere rift in the mountain. This extends another half mile, the walls gradually approaching till they are only two feet apart, and the bottom rising steeply to a pass which leads probably into another valley but which I had no time to explore. Returning to where this rift had begun, the main path turns up to the left in a sort of gulley, and reaches a summit over which a fine natural arch of rock passes at a height of about fifty feet. Thence was a steep descent through thick jungle with glimpses of precipices and distant rocky mountains, probably leading into the main river valley again. This was a most tempting region to explore, but there were several reasons why I could go no further. I had no guide, and no permission to enter the Bugis territories, and as the rains might at any time set in, I might be prevented from returning by the flooding of the river. I therefore devoted myself during the short time of my visit to obtaining what knowledge I could of the natural productions of the place.

The narrow chasms produced several fine insects quite new to me, and one new bird, the curious *Phlægenas tristigmata*, a large ground-pigeon with yellow breast and crown and purple neck. This rugged path is the highway from Máros to the Bugis country beyond the mountains. During the rainy season it is quite impassable, the river filling its bed and rushing between perpendicular cliffs many hundred feet high. Even at the time of my visit it was most precipitous and fatiguing, yet women and children came over it daily, and men carrying heavy loads of palm-sugar of very little value. It was along the path between the lower and the upper falls, and about the margin of the upper pool, that I found most insects. The large semi-transparent butterfly (*Idea tondana*) flew lazily along by dozens, and it was here that I at length obtained an insect which I had hoped but hardly expected to meet with — the magnificent *Papilio androcles*, one of the largest and rarest known swallow-tailed butterflies. During my four days' stay at the falls I was so fortunate as to obtain six good specimens. As this beautiful creature flies, the long white tails flicker like streamers, and when settled on the beach it carries them raised upward, as if to preserve them from injury. It is scarce even here, as I did not see more than a dozen specimens in all, and had to follow many of them up and down the river's bank repeatedly before I succeeded in their capture. When the sun shone hottest about noon, the moist beach of the pool below the upper fall presented a beautiful sight, being dotted with groups of gay butterflies — orange, yellow, white, blue, and green — which on being disturbed rose into the air by hundreds, forming clouds of variegated colors.

Such gorges, chasms, and precipices as here abound, I have nowhere seen in the Archipelago. A sloping surface is scarcely anywhere to be found, huge walls and rugged masses of rock terminating all the mountains and inclosing the valleys. In many parts there are vertical or even overhanging precipices five or six hundred feet high, yet completely clothed with a tapestry of vegetation. Ferns, *Pandanaceæ*, shrubs, creepers, and even forest-trees are mingled in an evergreen network, through the interstices of which appears the white limestone rock, or the dark holes and chasms with which it abounds. These precipices are enabled to sustain such an amount of vegetation by their peculiar structure. Their surfaces are very irregular, broken into holes and fissures, with ledges overhanging the mouths

of gloomy caverns; but from each projecting part have descended stalactites, often forming a wild Gothic tracery over the caves and receding hollows, and affording an admirable support to the roots of the shrubs, trees, and creepers, which luxuriate in the warm pure atmosphere and the gentle moisture which constantly exudes from the rocks. In places where the precipice offers smooth surfaces of solid rock, it remains quite bare, or only stained with lichens and dotted with clumps of ferns that grow on the small ledges and in the minutest crevices.

The reader who is familiar with tropical nature only through the medium of books and botanical gardens, will picture to himself in such a spot many other natural beauties. He will think that I have unaccountably forgotten to mention the brilliant flowers, which, in gorgeous masses of crimson gold or azure, must spangle these verdant precipices, hang over the cascade, and adorn the margin of the mountain stream. But what is the reality? In vain did I gaze over these vast walls of verdure, among the pendent creepers and bushy shrubs, all around the cascade, on the river's bank, or in the deep caverns and gloomy fissures — not one single spot of bright color could be seen, not one single tree or bush or creeper bore a flower sufficiently conspicuous to form an object in the landscape. In every direction the eye rested on green foliage and mottled rock. There was infinite variety in the color and aspect of the foliage, there was grandeur in the rocky masses and in the exuberant luxuriance of the vegetation, but there was no brilliancy of color, none of those bright flowers and gorgeous masses of blossom, so generally considered to be everywhere present in the tropics. I have here given an accurate sketch of a luxuriant tropical scene as noted down on the spot, and its general characteristics as regards color have been so often repeated, both in South America and over many thousand miles in the Eastern tropics, that I am driven to conclude that it represents the general aspect of nature in the equatorial (that is, the most tropical) parts of the tropical regions. How is it, then, that the descriptions of travellers generally give a very different idea? and where, it may be asked, *are* the glorious flowers that we know do exist in the tropics? These questions can be easily answered. The fine tropical flowering-plants cultivated in our hot-houses have been culled from the most varied regions, and therefore give a most erroneous idea of their abundance in any one region. Many of them are very rare, others extremely local, while a considerable number inhabit the more arid regions of Africa and India, in which tropical vegetation does not exhibit itself in its usual luxuriance. Fine and varied foliage, rather than gay flowers, is more characteristic of those parts where tropical vegetation attains its highest development, and in such districts each kind of flower seldom lasts in perfection more than a few weeks, or sometimes a few days. In every locality a lengthened residence will show an abundance of magnificent and gayly-blossomed plants, but they have to be sought for, and are rarely at any one time or place so abundant as to form a perceptible feature in the landscape. But it has been the custom of travellers to describe and group together all the fine plants they have met with during a long journey, and thus produce the effect of a gay and flower-painted landscape. They have rarely studied and described individual scenes where vegetation was most luxuriant and beautiful, and fairly stated what effect was produced in them by flowers. I have done so frequently, and the result of these examinations has convinced me that the bright colors of flowers have a much greater influence on the general aspect of nature in temperate than in tropical climates. During twelve years spent amid the grandest tropical vegetation I have seen nothing comparable to the effect produced on our landscapes by gorse, broom, heather, wild hyacinths, hawthorn, purple orchises, and buttercups.

The geological structure of this part of Celebes is interesting. The limestone mountains, though of great extent, seem to be entirely superficial, resting on a basis of basalt which in some places forms low rounded hills between the more precipitous mountains. In the rocky beds of the streams basalt is almost always found, and it is a step in this rock which forms the cascade already described. From it the limestone precipices rise abruptly; and in ascending the little stairway along the side of the fall, you step two or three times from the one rock on to the other, the limestone dry and rough, being worn by the water and rains into sharp ridges and honey-combed holes, the basalt moist, even, and worn smooth and slippery by the passage of bare-footed pedestrians. The solubility of the limestone by rain-water is well seen in the little blocks and peaks which rise thickly through the soil of the alluvial plains as you approach the mountains. They are all skittle-shaped, larger in the middle than at the base, the greatest diameter occurring at the height to which the country is flooded in the wet season, and thence decreasing regularly to the ground. Many of them overhang considerably, and some of the slenderer pillars appear to stand upon a point. When the rock is less solid it becomes curiously honey-combed by the rains of successive winters, and I noticed some masses reduced to a complete network of stone, through which light could be seen in every direction. From these mountains to the sea extends a perfectly flat alluvial plain, with no indication that water would accumulate at a great depth beneath it, yet the authorities at Macassar have spent much money in boring a well a thousand feet deep in hope of getting a supply of water like that obtained by the Artesian wells in the London and Paris basins. It is not to be wondered at that the attempt was unsuccessful.

Returning to my forest hut, I continued my daily search after birds and insects. The weather, however, became dreadfully hot and dry, every drop of water disappearing from the pools and rock-holes, and with it the insects which frequented them. Only one group remained unaffected by the intense drought; the *Diptera*, or two-winged flies, continued as plentiful as ever, and on these I was almost compelled to concentrate my attention for a week or two, by which means I increased my collection of that order to about two hundred species. I also continued to obtain a few new birds, among which were two or three kinds of small hawks and falcons, a beautiful brush-tongued paroquet (*Trichoglossus ornatus*), and a rare black and white crow (*Corvus advena*).

At length about the middle of October, after several gloomy days, down came a deluge of rain, which continued to fall almost every afternoon, showing that the early part of the wet season had commenced. I hoped now to get a good harvest of insects, and in some respects I was not disappointed. Beetles became much more numerous, and under a thick bed of leaves that had accumulated on some rock by the side of a forest stream I found abundance of *Carabidæ*, a family generally scarce in the tropics. The butterflies, however, disappeared. Two of my servants were attacked with fever, dysentery, and swelled feet just at the time that the third had left me, and for some days they both lay groaning in the house. When they got a little better I was attacked myself; and as my stores were nearly finished and every thing was getting very damp, I was obliged to prepare for my return to Macassar, especially as the strong westerly winds would render the passage in a small open boat disagreeable if not dangerous.

Since the rains began, numbers of huge *Millipedes* as thick as one's finger and eight or ten inches long crawled about everywhere, in the paths, on trees, about the house, and one morning when I got up I even found one in my bed! They were generally of a dull lead color or of a deep brick-red, and were very nasty-looking things to be coming everywhere in one's way, although quite harmless. Snakes too began to show themselves. I killed two of a very abundant species, big-headed and of a bright green color, which lie coiled up on leaves and shrubs, and can scarcely be seen till one is close upon them. Brown snakes got into my net while beating among dead leaves for insects, and made me rather cautious about inserting my hand till I knew what kind of game I had captured. The fields and meadows, which had been parched and sterile, now became suddenly covered with fine long grass; the river-bed, where I had so many times walked over burning rocks, was now a deep and rapid stream; and numbers of herbaceous plants and shrubs were everywhere springing up and bursting into flower. I found plenty of new insects, and if I had had a good, roomy, water-and-wind-proof house, I should perhaps have staid during the wet season, as I feel sure many things can then be obtained which are to be found at no other time. With my summer hut, however, this was impossible. During the heavy rains a fine drizzly mist penetrated into every part of it, and I began to have the greatest difficulty in keeping my specimens dry.

Early in November I returned to Macassar, and having packed up my collections, started in the Dutch mail-steamer for Amboyna and Ternate. Leaving this part of my journey for the present, I will in the next chapter conclude my account of Celebes by describing the extreme northern part of the island, which I visited two years later.

It was after my residence at Timor-coupang that I visited the north-eastern extremity of Celebes, touching on my way at Banda, Amboyna, and Ternate. I reached Menado on the 10th of June, 1859, and was very kindly received by Mr. TOWER, an Englishman, but a very old resident in Menado, where he carries on a general business. He introduced me to Mr. L. DUIVENBODEN (whose father had been my friend at Ternate), who had much taste for natural history, and to Mr. NEYS, a native of Menado, but who was educated at Calcutta, and to whom Dutch, English and Malay were equally mother-tongues. All these gentlemen showed me the greatest kindness, accompanied me in my earliest walks about the country, and assisted me by every means in their power. I spent a week in the town very pleasantly, making explorations and inquiries after a good collecting-station, which I had much difficulty in finding, owing to the wide cultivation of coffee and cacao, which has led to the clearing away of the forest for many miles round the town, and over extensive districts far into the interior.

The little town of Menado is one of the prettiest in the East. It has the appearance of a large garden, containing rows of rustic villas, with broad paths between, forming streets generally at right angles with each other. Good roads branch off in several directions toward the interior, with a succession of pretty cottages, neat gardens, and thriving plantations, interspersed with wildernesses of fruit-trees. To the west and south the country is mountainous, with groups of fine volcanic peaks 6000 or 7000 feet high, forming grand and picturesque back-grounds to the landscape.

The inhabitants of Minahasa (as this part of Celebes is called) differ much from those of all the rest of the island, and in fact from any other people in the Archipelago. They are of a light-brown or yellow tint, often approaching the fairness of a European; of a rather short stature, stout and well-made; of an open and pleasing countenance, more or less disfigured as age increases by projecting cheek-bones; and with the usual long, straight, jet-black hair of the Malayan races. In some of the inland villages, where they may be supposed to be of the purest race, both men and women are remarkably handsome; while nearer the coast, where the purity of their blood has been destroyed by the intermixture of other races, they approach to the ordinary types of the wild inhabitants of the surrounding countries.

In mental and moral characteristics they are also highly peculiar. They are remarkably quiet and gentle in disposition, submissive to the authority of those they consider their superiors, and easily induced to learn and adopt the habits of civilized people. They are clever mechanics, and seem capable of acquiring a considerable amount of intellectual education.

Up to a very recent period these people were thorough savages, and there are persons now living in Menado who remember a state of things identical with that described by the writers of the sixteenth and seventeenth centuries. The inhabitants of the several villages were distinct tribes, each under its own chief, speaking languages unintelligible to each other, and almost always at war. They built their houses elevated upon lofty posts to defend themselves from the attacks of their enemies. They were head-hunters, like the Dyaks of Borneo, and were said to be sometimes cannibals. When a chief died, his tomb was adorned with two fresh human heads; and if those of enemies could not be obtained, slaves were killed for the occasion. Human skulls were the great ornaments of the chiefs' houses. Strips of bark were their only dress. The country was a pathless wilderness, with small cultivated patches of rice and vegetables, or clumps of fruit-trees, diversifying the otherwise unbroken forest. Their religion was that naturally engendered in the undeveloped human mind by the contemplation of grand natural phenomena and the luxuriance of tropical nature. The burning mountain, the torrent and lake, were the abode of their deities, and certain trees and birds were supposed to have especial influence over men's actions and destiny. They held wild and exciting festivals to propitiate these deities or demons, and believed that men could be changed by them into animals, either during life or after death.

Here we have a picture of true savage life, of small isolated communities, at war with all around them, subject to the wants and miseries of such a condition, drawing a precarious existence from the luxuriant soil, and living on from generation to generation, with no desire for physical amelioration, and no prospect of moral advancement.

Such was their condition down to the year 1822, when the coffee-plant was first introduced, and experiments were made as to its cultivation. It was found to succeed admirably at from fifteen hundred up to four thousand feet above the sea. The chiefs of villages were induced to undertake its cultivation. Seed and native instructors were sent from Java; food was supplied to the laborers engaged in clearing and planting; a fixed price was established at which all coffee brought to the Government collectors was to be paid for, and the village chiefs, who now received the titles of "majors," were to receive five per cent. of the produce. After a time roads were made from the port of Menado up to the plateau, and smaller paths were cleared from village to village; missionaries settled in the more populous districts and opened schools, and Chinese traders penetrated to the interior and supplied clothing and other luxuries in exchange for the money which the sale of the coffee had produced. At the same time the country was divided into districts, and the system of "controlleurs," which had worked so well in Java, was introduced. The controlleur was a European, or a native of European blood, who was the general superintendent of the cultivation of the district, the adviser of the chiefs, the protector of the people, and the means of communication between both and the European Government. His duties obliged him to visit every village in succession once a month, and to send in a report on their condition to the Resident. As disputes between adjacent villages were now settled by appeal to a superior authority, the old and inconvenient semi-fortified houses were disused, and under the direction of the controlleurs most of the houses were rebuilt on a neat and uniform plan. It was this interesting district which I was now about to visit.

Having decided on my route, I started at 8 A.M. on the 22d of June. Mr. TOWER drove me the first three miles in his chaise, and Mr. NEYS accompanied me on horseback three miles further to the village of Lotta. Here we met the controlleur of the district of Tondáno, who was returning home from one of his monthly tours, and who had agreed to act as my guide and companion on the journey. From Lotta we had an almost continual ascent for six miles, which brought us on to the plateau of Tondáno at an elevation of about 2400 feet. We passed through three villages whose neatness and beauty quite astonished me. The main road, along which all the coffee is brought down from the interior in carts drawn by buffaloes, is always turned aside at the entrance of a village, so as to pass behind it, and thus allow the village street itself to be kept neat and clean. This is bordered by neat hedges often formed entirely of rose-trees, which are perpetually in blossom. There is a broad central path and a border of fine turf, which is kept well swept and neatly cut. The houses are all of wood, raised about six feet on substantial posts neatly painted blue, while the walls are whitewashed. They all have a veranda inclosed with a neat balustrade, and are generally surrounded by orange-trees and flowering shrubs. The surrounding scenery is verdant and picturesque. Coffee plantations of extreme luxuriance, noble palms and tree-ferns, wooded hills and volcanic peaks, everywhere meet the eye. I had heard much of the beauty of this country, but the reality far surpassed my expectations.

About one o'clock we reached Tomohón, the chief place of a district, having a native chief, now called the major, at whose house we were to dine. Here was a fresh surprise for me. The house was large, airy, and very substantially built of hard native timber, squared and put together in a most workmanlike manner. It was furnished in European style, with handsome chandelier lamps, and the chairs and tables all well made by native workmen. As soon as we entered, Madeira and bitters were offered us. Then two handsome boys, neatly dressed in white and with smoothly-brushed jet-black hair, handed us each a basin of water and a clean napkin on a salver. The dinner was excellent. Fowls cooked in various ways, wild pig roasted, stewed, and fried, a fricassee of bats, potatoes, rice, and other vegetables, all served on good china, with finger-glasses and fine napkins, and abundance of good claret and beer, seemed to me rather curious at the table of a native chief on the mountains of Celebes. Our host was dressed in a suit of black, with patent-leather shoes, and really looked comfortable and almost gentlemanly in them. He sat at the head of the table, and did the honors well, though he did not talk much. Our conversation was entirely in Malay, as that is the official language here, and in fact the mother-tongue and only language of the controlleur, who is a native-born

half-breed. The major's father, who was chief before him, wore, I was informed, a strip of bark as his sole costume, and lived in a rude hut raised on lofty poles, and abundantly decorated with human heads. Of course we were expected and our dinner was prepared in the best style, but I was assured that the chiefs all take a pride in adopting European customs, and in being able to receive their visitors in a handsome manner.

After dinner and coffee the controlleur went on to Tondâno, and I strolled about the village waiting for my baggage, which was coming in a bullock-cart, and did not arrive till after midnight. Supper was very similar to dinner, and on retiring I found an elegant little room with a comfortable bed, gauze curtains with blue and red hangings, and every convenience. Next morning at sunrise the thermometer in the veranda stood at 69°, which I was told is about the usual lowest temperature at this place, 2500 feet above the sea. I had a good breakfast of coffee, eggs, and fresh bread and butter, which I took in the spacious veranda, amid the odor of roses, jessamine, and other sweet-scented flowers, which filled the garden in front; and about eight o'clock left Tomohón, with a dozen men carrying my baggage.

Our road lay over a mountain ridge about 4000 feet above the sea, and then descended about 500 feet to the little village of Rurúkan, the highest in the district of Minahasa, and probably in all Celebes. Here I had determined to stay for some time to see whether this elevation would produce any change in the zoology. The village had only been formed about ten years, and was quite as neat as those I had passed through, and much more picturesque. It is placed on a small level spot, from which there is an abrupt wooded descent down to the beautiful lake of Tondâno, with volcanic mountains beyond. On one side is a ravine, and beyond it a fine mountainous and wooded country.

Near the village are the coffee plantations. The trees are planted in rows, and are kept topped to about seven feet high. This causes the lateral branches to grow very strong, so that some of the trees become perfect hemispheres, loaded with fruit from top to bottom, and producing from ten to twenty pounds each of cleaned coffee annually. These plantations were all formed by the Government, and are cultivated by the villagers under the direction of their chief. Certain days are appointed for weeding or gathering, and the whole working population are summoned by sound of gong. An account is kept of the number of hours' work done by each family, and at the year's end the produce of the sale is divided among them proportionately. The coffee is taken to Government stores established at central places over the whole country, and is paid for at a low fixed price. Out of this a certain percentage goes to the chiefs and majors, and the remainder is divided among the inhabitants. This system works very well, and I believe is at present far better for the people than free trade would be. There are also large rice-fields, and in this little village of seventy houses I was informed that a hundred pounds' worth of rice was sold annually.

I had a small house at the very end of the village, almost hanging over the precipitous slope down to the stream, and with a splendid view from the veranda. The thermometer in the morning often stood at 62°, and never rose so high as 80°; so that with the thin clothing used in the tropical plains we were always cool, and sometimes positively cold, while the spout of water where I went daily for my bath had quite an icy feel. Although I enjoyed myself very much among these fine mountains and forests, I was somewhat disappointed as to my collections. There was hardly any perceptible difference between the animal life in this temperate region and in the torrid plains below, and what difference did exist was in most respects disadvantageous to me. There seemed to be nothing absolutely peculiar to this elevation. Birds and quadrupeds were less plentiful, but of the same species. In insects there seemed to be more difference. The curious beetles of the family *Cleridæ*, which are found chiefly on bark and rotten wood, were finer than I have seen them elsewhere. The beautiful *Longicorns* were scarcer than usual, and the few butterflies were all of tropical species. One of these, *Papilio blumei*, of which I obtained a few specimens only, is among the most magnificent I have ever seen. It is a green and gold swallowtail, with azure-blue spoon-shaped tails, and was often seen flying about the village when the sun shone, but in a very shattered condition. The great amount of wet and cloudy weather was a great drawback all the time I was at Rurúkan.

Even in the vegetation there is very little to indicate elevation. The trees are more covered with lichens and mosses, and the ferns and tree-ferns are finer and more luxuriant than I had been accustomed to see them on the low grounds, both probably attributable to the almost perpetual moisture that here prevails. Abundance of a tasteless raspberry, with blue and yellow *Compositæ*, have somewhat of a temperate aspect, and minute ferns and *Orchideæ*, with dwarf *Begonias* on the rocks, make some approach to a sub-alpine vegetation. The forest, however, is most luxuriant. Noble palms, *Pandani*, and tree-ferns are abundant in it, while the forest-trees are completely festooned with *Orchideæ*, *Bromelideliæ*, *Araceæ*, *Lycopodiums*, and mosses. The ordinary stemless ferns abound; some with gigantic fronds ten or twelve feet long, others barely an inch high; some with entire and massive leaves, others elegantly waving their finely-cut foliage, and adding endless variety and interest to the forest paths. The cocoanut palm still produces fruit abundantly, but is said to be deficient in oil. Oranges thrive better than below, producing abundance of delicious fruit; but the shaddock or pumplemous (*Citrus decumana*) requires the full force of a tropical sun, for it will not thrive even at Tondâno, a thousand feet lower. On the hilly slopes rice is cultivated largely, and ripens well, although the temperature rarely or never rises to 80°, so that one would think it might be grown even in England in fine summers, especially if the young plants were raised under glass.

The mountains have an unusual quantity of earth or vegetable mould spread over them. Even on the steepest slopes there is everywhere a covering of clays and sands, and generally a good thickness of vegetable soil. It is this which perhaps contributes to the uniform luxuriance of the forest, and delays the appearance of that sub-alpine vegetation which depends almost as much on the abundance of rocky and exposed surfaces as on difference of climate. At a much lower elevation on Mount Ophir, in Malacca, *Dacrydiums* and *Rhododendrons*, with abundance of *Nepenthes*, ferns, and terrestrial orchids suddenly took the place of the lofty forest; but this was plainly due to the occurrence of an extensive slope of bare granitic rock at an elevation of less than 3000 feet. The quantity of vegetable soil, and also of loose sands and clays, resting on steep slopes, hill-tops, and the sides of ravines, is a curious and important phenomenon. It may be due in part to constant slight earthquake shocks, facilitating the disintegration of rock; but would also seem to indicate that the country has been long exposed to gentle atmospheric action, and that its elevation has been exceedingly slow and continuous.

During my stay at Rurúkan my curiosity was satisfied by experiencing a pretty sharp earthquake-shock. On the evening of June 29, at a quarter after eight, as I was sitting reading, the house began shaking with a very gentle, but rapidly increasing motion. I sat still enjoying the novel sensation for some seconds; but in less than half a minute it became strong enough to shake me in my chair, and to make the house visibly rock about, and creak and crack as if it would fall to pieces. Then began a cry throughout the village of "Tana goyang! tana goyang!" (Earthquake! earthquake)! Every body rushed out of their houses — women screamed and children cried — and I thought it prudent to go out too. On getting up, I found my head giddy and my steps unsteady, and could hardly walk without falling. The shock continued about a minute, during which time I felt as if I had been turned round and round, and was almost sea-sick. Going into the house again, I found a lamp and a bottle of arrack upset. The tumbler which formed the lamp had been thrown out of the saucer in which it had stood. The shock appeared to be nearly vertical, rapid, vibratory, and jerking. It was sufficient, I have no doubt, to have thrown down brick chimneys and walls and church towers; but as the houses here are all low, and strongly framed of timber, it is impossible for them to be much injured, except by a shock that would utterly destroy a European city. The people told me it was ten years since they had had a stronger shock than this, at which time many houses were thrown down and some people killed.

At intervals of ten minutes to half an hour, slight shocks and tremors were felt, sometimes strong enough to send us all out again. There was a strange mixture of the terrible and ludicrous in our situation. We might at any moment have a much stronger shock, which would bring down the house over us, or — what I feared more — cause a landslip, and send us down into the deep ravine on the very edge

of which the village is built; yet I could not help laughing each time we ran out at a slight shock, and then in a few moments ran in again. The sublime and the ridiculous were here literally but a step apart. On the one hand, the most terrible and destructive of natural phenomena was in action around us — the rocks, the mountains, the solid earth were trembling and convulsed, and we were utterly impotent to guard against the danger that might at any moment overwhelm us. On the other hand was the spectacle of a number of men, women, and children running in and out of their houses, on what each time proved a very unnecessary alarm, as each shock ceased just as it became strong enough to frighten us. It seemed really very much like "playing at earthquakes," and made many of the people join me in a hearty laugh, even while reminding each other that it really might be no laughing matter.

At length the evening got very cold, and I became very sleepy, and determined to turn in, leaving orders to my boys, who slept nearer the door, to wake me in case the house was in danger of falling. But I miscalculated my apathy, for I could not sleep much. The shocks continued at intervals of half an hour or an hour all night, just strong enough to wake me thoroughly each time and keep me on the alert ready to jump up in case of danger. I was therefore very glad when morning came. Most of the inhabitants had not been to bed at all, and some had staid out-of-doors all night. For the next two days and nights shocks still continued at short intervals, and several times a day for a week, showing that there was some very extensive disturbance beneath our portion of the earth's crust. How vast the forces at work really are can only be properly appreciated when, after feeling their effects, we look abroad over the wide expanse of hill and valley, plain and mountain, and thus realize in a slight degree the immense mass of matter heaved and shaken. The sensation produced by an earthquake is never to be forgotten. We feel ourselves in the grasp of a power to which the wildest fury of the winds and waves are as nothing; yet the effect is more a thrill of awe than the terror which the more boisterous war of the elements produces. There is a mystery and an uncertainty as to the amount of danger we incur, which gives greater play to the imagination, and to the influences of hope and fear. These remarks apply only to a moderate earthquake. A severe one is the most destructive and the most horrible catastrophe to which human beings can be exposed.

A few days after the earthquake I took a walk to Tondáno, a large village of about 7000 inhabitants, situated at the lower end of the lake of the same name. I dined with the controlleur, Mr. BENSNEIDER, who had been my guide to Tomohón. He had a fine large house, in which he often received visitors; and his garden was the best for flowers which I had seen in the tropics, although there was no great variety. It was he who introduced the rose hedges which give such a charming appearance to the villages, and to him is chiefly due the general neatness and good order that everywhere prevail. I consulted him about a fresh locality, as I found Rurúkan too much in the clouds, dreadfully damp and gloomy, and with a general stagnation of bird and insect life. He recommended me a village some distance beyond the lake, near which was a large forest, where he thought I should find plenty of birds. As he was going himself in a few days, I decided to accompany him.

After dinner I asked him for a guide to the celebrated waterfall on the outlet stream of the lake. It is situated about a mile and a half below the village, where a slight rising ground closes in the basin, and evidently once formed the shore of the lake. Here the river enters a gorge, very narrow and tortuous, along which it rushes furiously for a short distance and then plunges into a great chasm, forming the head of a large valley. Just above the fall the channel is not more than ten feet wide, and here a few planks are thrown across, whence, half hid by luxuriant vegetation, the mad waters may be seen rushing beneath, and a few feet farther plunge into the abyss. Both sight and sound are grand and impressive . . .

Unfortunately, no good view of the fall could now be obtained, owing to the quantity of wood and high grass that lined the margins of the precipices. There are two falls, the lower being the most lofty; and it is possible, by a long circuit, to descend into the valley and see them from below. Were the best points of view searched for and rendered accessible, these falls would probably be found to be the finest in the Archipelago. The chasm seems to be of great depth, probably 500 or 600 feet. Unfortunately, I had no time to explore this valley, as I was anxious to devote every fine day to increasing my hitherto scanty collections.

Just opposite my abode in Rurúkan was the school-house. The school-master was a native, educated by the missionary at Tomohón. School was held every morning for about three hours, and twice a week in the evening there was catechising and preaching. There was also a service on Sunday morning. The children were all taught in Malay, and I often heard them repeating the multiplication-table up to twenty times twenty very glibly. They always wound up with singing, and it was very pleasing to hear many of our old psalm-tunes in these remote mountains sung with Malay words. Singing is one of the real blessings which missionaries introduce among savage nations, whose native chants are almost always monotonous and melancholy.

On catechising evenings the school-master was a great man, preaching and teaching for three hours at a stretch much in the style of an English ranter. This was pretty cold work for his auditors, however warming to himself; and I am inclined to think that these native teachers, having acquired facility of speaking and an endless supply of religious platitudes to talk about, ride their hobby rather hard, without much consideration for their flock. The missionaries, however, have much to be proud of in this country. They have assisted the Government in changing a savage into a civilized community in a wonderfully short space of time. Forty years ago the country was a wilderness, the people naked savages, garnishing their rude houses with human heads. Now it is a garden, worthy of its sweet native name of "Minahasa." Good roads and paths traverse it in every direction; some of the finest coffee plantations in the world surround the villages, interspersed with extensive rice-fields more than sufficient for the support of the population.

The people are now the most industrious, peaceable, and civilized in the whole Archipelago. They are the best clothed, the best housed, the best fed, and the best educated, and they have made some progress toward a higher social state. I believe there is no example elsewhere of such striking results being produced in so short a time — results which are entirely due to the system of government now adopted by the Dutch in their Eastern possessions. The system is one which may be called a "paternal despotism." Now we Englishmen do not like despotism — we hate the name and the thing, and we would rather see people ignorant, lazy, and vicious, than use any but moral force to make them wise, industrious, and good. And we are right when we are dealing with men of our own race, and of similar ideas and equal capacities with ourselves. Example and precept, the force of public opinion, and the slow, but sure spread of education, will do every thing in time, without engendering any of those bitter feelings, or producing any of that servility, hypocrisy, and dependence, which are the sure results of despotic government. But what should we think of a man who should advocate these principles of perfect freedom in a family or a school? We should say that he was applying a good general principle to a case in which the conditions rendered it inapplicable — the case in which the governed are in an admitted state of mental inferiority to those who govern them, and are unable to decide what is best for their permanent welfare. Children must be subjected to some degree of authority, and guidance; and if properly managed they will cheerfully submit to it, because they know their own inferiority, and believe their elders are acting solely for their good. They learn many things the use of which they cannot comprehend, and which they would never learn without some moral and social, if not physical pressure. Habits of order, of industry, of cleanliness, of respect and obedience, are inculcated by similar means. Children would never grow up into well-behaved and well-educated men, if the same absolute freedom of action that is allowed to men were allowed to them. Under the best aspect of education, children are subjected to a mild despotism for the good of themselves and of society; and their confidence in the wisdom and goodness of those who ordain and apply this despotism, neutralizes the bad passions and degrading feelings, which under less favorable conditions are its general results . . .

If we are satisfied that we are right in assuming the government over a savage race and occupying their country; and if we further consider it our duty to do what we can to improve our rude subjects and raise them up toward our own level, we must not be too much afraid of the cry

of "despotism" and "slavery," but must use the authority we possess to induce them to do work which they may not altogether like, but which we know to be an indispensable step in their moral and physical advancement. The Dutch have shown much good policy in the means by which they have done this. They have in most cases upheld and strengthened the authority of the native chiefs, to whom the people have been accustomed to render a voluntary obedience; and by acting on the intelligence and self-interest of these chiefs, have brought about changes in the manners and customs of the people, which would have excited ill-feeling and perhaps revolt, had they been directly enforced by foreigners.

In carrying out such a system, much depends upon the character of the people; and the system which succeeds admirably in one place could only be very partially worked out in another. In Minahasa the natural docility and intelligence of the race have made their progress rapid; and how important this is, is well illustrated by the fact that in the immediate vicinity of the town of Menado is a tribe called Banteks, of a much less tractable disposition, who have hitherto resisted all efforts of the Dutch Government to induce them to adopt any systematic cultivation. These remain in a ruder condition, but engage themselves willingly as occasional porters and laborers, for which their greater strength and activity well adapt them.

No doubt the system here sketched seems open to serious objection. It is to a certain extent despotic, and interferes with free trade, free labor, and free communication. A native can not leave his village without a pass, and can not engage himself to any merchant or captain without a Government permit. The coffee has all to be sold to Government, at less than half the price that the local merchant would give for it, and he consequently cries out loudly against "monopoly" and "oppression." He forgets, however, that the coffee-plantations were established by the Government at great outlay of capital and skill; that it gives free education to the people, and that the monopoly is in lieu of taxation. He forgets that the product he wants to purchase and make a profit by, is the creation of the Government, without whom the people would still be savages. He knows very well that free trade would, as its first result, lead to the importation of whole cargoes of arrack, which would be carried over the country and exchanged for coffee; that drunkenness and poverty would spread over the land; that the public coffee-plantations would not be kept up; that the quality and quantity of the coffee would soon deteriorate; that traders and merchants would get rich, but that the people would relapse into poverty and barbarism. That such is invariably the result of free trade with any savage tribes who possess a valuable product, native or cultivated, is well known to those who have visited such people; but we might even anticipate from general principles that evil results would happen. If there is one thing rather than another to which the grand law of continuity or development will apply, it is human progress. There are certain stages through which society must pass, in its onward march from barbarism to civilization. Now one of these stages has always been some form or other of despotism, such as feudalism or servitude, or a despotic paternal government; and we have every reason to believe that it is not possible for humanity to leap over this transition epoch, and pass at once from pure savagery to free civilization. The Dutch system attempts to supply this missing link, and to bring the people on by gradual steps to the higher civilization which we (the English) try to force upon them at once. Our system has always failed. We demoralize and we extirpate, but we never really civilize. Whether the Dutch system can permanently succeed is but doubtful, since it may not be possible to compress the work of ten centuries into one; but at all events it takes nature as a guide, and is therefore more deserving of success, and more likely to succeed than ours.

There is one point connected with this question which I think the missionaries might take up with great physical and moral results. In this beautiful and healthy country, and with abundance of food and necessaries, the population does not increase as it ought to do. I can only impute this to one cause — infant mortality, produced by neglect while the mothers are working in the plantations, and by general ignorance of the conditions of health in infants. Women all work, as they have always been accustomed to do. It is no hardship to them, but I believe is often a pleasure and relaxation. They either take their infants with them, in which case they leave them in some shady spot on the ground, going at intervals to give them nourishment, or they leave them at home in the care of other children too young to work. Under neither of these circumstances can infants be properly attended to, and great mortality is the result, keeping down the increase of population far below the rate which the general prosperity of the country and the universality of marriage would lead us to expect. This is a matter in which the Government is directly interested, since it is by the increase of the population alone that there can be any large and permanent increase in the produce of coffee. The missionaries should take up the question, because, by inducing married women to confine themselves to domestic duties, they will decidedly promote a higher civilization, and directly increase the health and happiness of the whole community. The people are so docile, and so willing to adopt the manners and customs of Europeans, that the change might be easily effected, by merely showing them that it was a question of morality and civilization, and an essential step in their progress toward an equality with their white rulers.

After a fortnight's stay at Rurúkan, I left that pretty and interesting village in search of a locality and climate more productive of birds and insects. I passed the evening with the controlleur of Tondáno, and the next morning at nine left in a small boat for the head of the lake, a distance of about ten miles. The lower end of the lake is bordered by swamps and marshes of considerable extent, but a little further on the hills come down to the water's edge, and give it very much the appearance of a great river, the width being about two miles. At the upper end is the village of Kákas, where I dined with the head-man in a good house like those I have already described, and then went on to Langówan, four miles distant, over a level plain. This was the place where I had been recommended to stay, and I accordingly unpacked my baggage and made myself comfortable in the large house devoted to visitors. I obtained a man to shoot for me, and another to accompany me the next day to the forest, where I was in hopes of finding a good collecting-ground.

In the morning after breakfast I started off, but found I had four miles to walk over a wearisome straight road through coffee-plantations before I could get to the forest, and as soon as I did so, it came on to rain heavily, and did not cease till night. This distance to walk every day was too far for any profitable work, especially when the weather was so uncertain. I therefore decided at once that I must go further on, till I found some place close to or in a forest country. In the afternoon my friend Mr. BENSNEIDER arrived, together with the controlleur of the next district, called Belang, from whom I learned that six miles further on there was a village called Panghu, which had been recently formed, and had a good deal of forest close to it, and he promised me the use of a small house if I liked to go there.

The next morning I went to see the hot springs and mud-volcanoes, for which this place is celebrated. A picturesque path among plantations and ravines brought us to a beautiful circular basin about forty feet diameter, bordered by a calcareous ledge, so uniform and truly curved that it looked like a work of art. It was filled with clear water very near the boiling-point, and emitting clouds of steam with a strong sulphureous odor. It overflows at one point and forms a little stream of hot water, which at a hundred yards' distance is still too hot to hold the hand in. A little further on, in a piece of rough wood, were two other springs, not so regular in outline, but appearing to be much hotter, as they were in a continual state of active ebullition. At intervals of a few minutes a great escape of steam or gas took place, throwing up a column of water three or four feet high.

We then went to the mud-springs, which are about a mile off, and are still more curious. On a sloping tract of ground in a slight hollow is a small lake of liquid mud, in patches of blue, red, or white, and in many places boiling and bubbling most furiously. All around on the indurated clay are small wells and craters, full of boiling mud. These seem to be forming continually, a small hole appearing first, which emits jets of steam and boiling mud, which, on hardening, forms a little cone, with a crater in the middle. The ground for some distance is very unsafe, as it is evidently liquid at a small depth, and bends with pressure like thin ice. At one of the smaller marginal jets which I managed to approach, I held my hand to see if it was really as hot as it looked, when a little drop of mud that spurted on to my finger scalded like boiling water. A short distance off there

was a flat bare surface of rock, as smooth and hot as an oven floor, which was evidently an old mud-pool dried up and hardened. For hundreds of yards round, where there were banks of reddish and white clay used for whitewash, it was still so hot close to the surface that the hand could hardly bear to be held in cracks a few inches deep, and from which arose a strong sulphureous vapor. I was informed that some years back a French gentleman who visited these springs ventured too near the liquid mud, when the crust gave way and he was engulfed in the horrible caldron.

This evidence of intense heat so near the surface over a large tract of country was very impressive, and I could hardly divest myself of the notion that some terrible catastrophe might at any moment devastate the country. Yet it is probable that all these apertures are really safety-valves, and that the inequalities of the resistance of various parts of the earth's crust will always prevent such an accumulation of force as would be required to upheave and overwhelm any extensive area. About seven miles west of this is a volcano which was in eruption about thirty years before my visit, presenting a magnificent appearance and covering the surrounding country with showers of ashes. The plains around the lake formed by the intermingling and decomposition of volcanic products are of amazing fertility, and with a little management in the rotation of crops might be kept in continual cultivation. Rice is now grown on them for three or four years in succession, when they are left fallow for the same period, after which rice or maize can be again grown. Good rice produces thirty-fold, and coffee-trees continue bearing abundantly for ten or fifteen years without any manure and with scarcely any cultivation.

I was delayed a day by incessant rain, and then proceeded to Panghu, which I reached just before the daily rain began at 11 A.M. After leaving the summit level of the lake basin, the road is carried along the slope of a fine forest ravine. The descent is a long one, so that I estimated the village to be not more than 1500 feet above the sea, yet I found the morning temperature often 69°, the same as at Tondáno, at least 600 or 700 feet higher. I was pleased with the appearance of the place, which had a good deal of forest and wild country around it, and found prepared for me a little house, consisting only of a veranda and a back room. This was only intended for visitors to rest in or to pass a night, but it suited me very well. I was so unfortunate, however, as to lose both my hunters just at this time. One had been left at Tondáno with fever and diarrhœa, and the other was attacked at Langówan with inflammation of the chest, and, as his case looked rather bad, I had him sent back to Menado. The people here were all so busy with their rice-harvest, which it was important for them to finish owing to the early rains, that I could get no one to shoot for me.

During the three weeks that I staid at Panghu it rained nearly every day, either in the afternoon only, or all day long; but there were generally a few hours' sunshine in the morning, and I took advantage of these to explore the roads and paths, the rocks and ravines, in search of insects. These were not very abundant, yet I saw enough to convince me that the locality was a good one, had I been there at the beginning instead of at the end of the dry season. The natives brought me daily a few insects obtained at the sagueir palms, including some fine *Cetonias* and stag-beetles. Two little boys were very expert with the blow-pipe, and brought me a good many small birds, which they shot with pellets of clay. Among these was a pretty little flower-pecker of a new species (*Prionochilus aureolimbatus*), and several of the loveliest honey-suckers I had yet seen. My general collection of birds was, however, almost at a stand-still; for though I at length obtained a man to shoot for me, he was not good for much, and seldom brought me more than one bird a day. The best thing he shot was the large and rare fruit-pigeon peculiar to Northern Celebes (*Carpophaga forsteni*), which I had long been seeking after.

I was myself very successful in one beautiful group of insects, the tiger-beetles, which seem more abundant and varied here than anywhere else in the Archipelago. I first met with them on a cutting in the road, where a hard clayey bank was partially overgrown with mosses and small ferns. Here I found running about a small olive-green species which never took flight, and more rarely a fine purplish-black wingless insect, which was always found motionless in crevices, and was therefore probably nocturnal. It appeared to me to form a new genus. About the roads in the forest I found the large and handsome *Cicindela heros*, which I had before obtained sparingly at Macassar; but it was in the mountain torrent of the ravine itself that I got my finest things. On dead trunks overhanging the water, and on the banks and foliage, I obtained three very pretty species of *Cicindela*, quite distinct in size, form, and color, but having an almost identical pattern of pale spots. I also found a single specimen of a most curious species with very long antennæ. But my finest discovery here was the *Cicindela gloriosa*, which I found on mossy stones just rising above the water. After obtaining my first specimen of this elegant insect, I used to walk up the stream, watching carefully every moss-covered rock and stone. It was rather shy, and would often lead me a long chase from stone to stone, becoming invisible every time it settled on the damp moss, owing to its rich velvety-green color. On some days I could only catch a few glimpses of it, on others I got a single specimen, and on a few occasions two, but never without a more or less active pursuit. This and several other species I never saw but in this one ravine.

Among the people here I saw specimens of several types, which, with the peculiarities of the languages, gives me some notion of their probable origin. A striking illustration of the low state of civilization of these people till quite recently is to be found in the great diversity of their languages. Villages three or four miles apart have separate dialects, and each group of three or four such villages has a distinct language quite unintelligible to all the rest; so that, till the recent introduction of Malay by the missionaries, there must have been a bar to all free communication. These languages offer many peculiarities. They contain a Celebes-Malay element and a Papuan element, along with some radical peculiarities found also in the languages of the Siau and Sanguir islands further north, and therefore probably derived from the Philippine Islands. Physical characters correspond. There are some of the less civilized tribes which have semi-Papuan features and hair, while in some villages the true Celebes or Bugis physiognomy prevails. The plateau of Tondáno is chiefly inhabited by people nearly as white as the Chinese, and with very pleasing semi-European features. The people of Siau and Sanguir much resemble these, and I believe them to be perhaps immigrants from some of the islands of North Polynesia. The Papuan type will represent the remnant of the aborigines, while those of the Bugis character show the extension northward of the superior Malay races.

As I was wasting valuable time at Panghu, owing to the bad weather and the illness of my hunters, I returned to Menado after a stay of three weeks. Here I had a little touch of fever, and what with drying and packing away my collections and getting fresh servants, it was a fortnight before I was again ready to start. I now went eastward over an undulating country skirting the great volcano of Klábat to a village called Lempías, situated close to the extensive forest that covers the lower slopes of that mountain. My baggage was carried from village to village by relays of men; and as each change involved some delay, I did not reach my destination (a distance of eighteen miles) till sunset. I was wet through, and had to wait for an hour in an uncomfortable state till the first installment of my baggage arrived, which luckily contained my clothes, while the rest did not come in till midnight.

This being the district inhabited by that singular animal the Babirúsa (hog-deer), I inquired about skulls, and soon obtained several in tolerable condition, as well as a fine one of the rare and curious "sapi-utan" (*Anoa depressicornis*). Of this animal I had seen two living specimens at Menado, and was surprised at their great resemblance to small cattle, or still more to the eland of South Africa. Their Malay name signifies "forest ox," and they differ from very small high-bred oxen principally by the low-hanging dewlap, and straight pointed horns which slope back over the neck. I did not find the forest here so rich in insects as I had expected, and my hunters got me very few birds, but what they did obtain were very interesting. Among these were the rare forest kingfisher (*Cittura cyanotis*), a small new species of *Megapodius*, and one specimen of the large and interesting maleo (*Megacephalon rubripes*), to obtain which was one of my chief reasons for visiting this district. Getting no more, however, after ten days' search, I removed to Licoupang, at the extremity of the peninsula, a place celebrated for these birds, as well as for the babirúsa and sapi-utan. I found here Mr. GOLDMANN, the eldest son of the Governor of the Moluccas, who was superintending the establishment of some Government salt-works. This was a better locality, and I obtained some fine butterflies and

very good birds, among which was one more specimen of the rare ground-dove (*Phlegœnas tristigmata*), which I had first obtained near the Máros waterfall in South Celebes.

Hearing what I was particularly in search of, Mr. GOLDMANN kindly offered to make a hunting-party to the place where the "maleos" are most abundant, a remote and uninhabited sea-beach about twenty miles distant. The climate here was quite different to that on the mountains, not a drop of rain having fallen for four months; so I made arrangements to stay on the beach a week, in order to secure a good number of specimens. We went partly by boat and partly through the forest, accompanied by the major, or head-man, of Licoupang, with a dozen natives and about twenty dogs. On the way they caught a young sapi-utan and five wild pigs. Of the former I preserved the head. This animal is entirely confined to the remote mountain forests of Celebes and one or two adjacent islands which form part of the same group. In the adults the head is black, with a white mark over each eye, one on each cheek and another on the throat. The horns are very smooth and sharp when young, but become thicker and ridged at the bottom with age. Most naturalists consider this curious animal to be a small ox, but from the character of the horns, the fine coat of hair, and the descending dewlap, it seemed closely to approach the antelopes.

Arrived at our destination we built a hut and prepared for a stay of some days, I to shoot and skin "maleos," Mr. GOLDMANN and the major to hunt wild pigs, babirúsa, and sapi-utan. The place is situated in the large bay between the islands of Limbé and Banca, and consists of a steep beach more than a mile in length, of deep, loose, and coarse black volcanic sand or rather gravel, very fatiguing to walk over. It is bounded at each extremity by a small river, with hilly ground beyond, while the forest behind the beach itself is tolerably level and its growth stunted. We have here probably an ancient lava-stream from the Klábat volcano, which has flowed down a valley into the sea, and the decomposition of which has formed the loose black sand. In confirmation of this view it may be mentioned, that the beaches beyond the small rivers in both directions are of white sand.

It is in this loose hot black sand that those singular birds the "maleos" deposit their eggs. In the months of August and September, when there is little or no rain, they come down in pairs from the interior to this or to one or two other favorite spots, and scratch holes three or four feet deep, just above high-water mark, where the female deposits a single large egg, which she covers over with about a foot of sand, and then returns to the forest. At the end of ten or twelve days she comes again to the same spot to lay another egg, and each female bird is supposed to lay six or eight eggs during the season. The male assists the female in making the hole, coming down and returning with her. The appearance of the bird when walking on the beach is very handsome. The glossy black and rosy white of the plumage, the helmeted head and elevated tail, like that of the common fowl, give a striking character, which their stately and somewhat sedate walk renders still more remarkable. There is hardly any difference between the sexes, except that the casque or bonnet at the back of the head and the tubercles at the nostrils are a little larger, and the beautiful rosy salmon color a little deeper in the male bird; but the difference is so slight that it is not always possible to tell a male from a female without dissection. They run quickly, but when shot at or suddenly disturbed take wing with a heavy noisy flight to some neighboring tree, where they settle on a low branch, and they probably roost at night in a similar situation. Many birds lay in the same hole, for a dozen eggs are often found together; and these are so large that it is not possible for the body of the bird to contain more than one fully-developed egg at the same time. In all the female birds which I shot, none of the eggs besides the one large one exceeded the size of peas, and there were only eight or nine of these, which is probably the extreme number a bird can lay in one season.

Every year the natives come for fifty miles round to obtain these eggs, which are esteemed a great delicacy, and when quite fresh are indeed delicious. They are richer than hen's eggs, and of a finer flavor, and each one completely fills an ordinary tea-cup, and forms, with bread or rice, a very good meal. The color of the shell is a pale brick-red, or very rarely pure white. They are elongate, and very slightly smaller at one end, from four to four and a half inches long by two and a quarter or two and a half wide.

After the eggs are deposited in the sand they are no further cared for by the mother. The young birds, on breaking the shell, work their way up through the sand and run off at once to the forest; and I was assured by Mr. DUIVENBODEN of Ternate that they can fly the very day they are hatched. He had taken some eggs on board his schooner, which hatched during the night, and in the morning the little birds flew readily across the cabin. Considering the great distances the birds come to deposit the eggs in a proper situation (often ten or fifteen miles), it seems extraordinary that they should take no further care of them. It is, however, quite certain that they neither do nor can watch them. The eggs being deposited by a number of hens in succession in the same hole, would render it impossible for each to distinguish its own, and the food necessary for such large birds (consisting entirely of fallen fruits) can only be obtained by roaming over an extensive district; so that if the numbers of birds which come down to this single beach in the breeding season, amounting to many hundreds, were obliged to remain in the vicinity, many would perish of hunger.

In the structure of the feet of this bird we may detect a cause for its departing from the habits of its nearest allies, the *Megapodii* and *Talegalli*, which heap up earth, leaves, stones, and sticks into a huge mound, in which they bury their eggs. The feet of the maleo are not nearly so large or strong in proportion as in these birds, while its claws are short and straight, instead of being long and much curved. The toes are, however, strongly webbed at the base, forming a broad, powerful foot, which, with the rather long leg, is well adapted to scratch away the loose sand (which flies up in a perfect shower when the birds are at work), but which could not without much labor accumulate the heaps of miscellaneous rubbish which the large, grasping feet of the *Megapodius* bring together with ease.

We may also, I think, see in the peculiar organization of the entire family of the *Megapodidæ*, or brush-turkeys, a reason why they depart so widely from the usual habits of the class of birds. Each egg being so large as entirely to fill up the abdominal cavity and with difficulty pass the walls of the pelvis, a considerable interval is required before the successive eggs can be matured (the natives say about thirteen days). Each bird lays six or eight eggs or even more each season, so that between the first and last there may be an interval of two or three months. Now, if these eggs were hatched in the ordinary way, either the parent must keep sitting continually for this long period; or if they only began to sit after the last egg was deposited, the first would be exposed to injury by the climate, or to destruction by the large lizards, snakes, or other animals which abound in the district, because such large birds must roam about a good deal in search of food. Here then we seem to have a case in which the habits of a bird may be directly traced to its exceptional organization; for it will hardly be maintained that this abnormal structure and peculiar food were given to the *Megapodidæ*, in order that they might not exhibit that parental affection, or possess those domestic instincts so general in the class of birds, and which so much excite our admiration.

It has generally been the custom of writers on natural history to take the habits and instincts of animals as fixed points, and to consider their structure and organization as specially adapted to be in accordance with these. This assumption is however an arbitrary one, and has the bad effect of stifling inquiry into the nature and causes of "instincts and habits," treating them as directly due to a "first cause," and therefore incomprehensible to us. I believe that a careful consideration of the structure of a species, and of the peculiar physical and organic conditions by which it is surrounded, or has been surrounded in past ages, will often, as in this case, throw much light on the origin of its habits and instincts. These again, combined with changes in external conditions, react upon structure, and by means of "variation" and "natural selection" both are kept in harmony.

My friends remained three days, and got plenty of wild pigs and two anóas, but the latter were much injured by the dogs, and I could only preserve the heads. A grand hunt which we attempted on the third day failed, owing to bad management in driving in the game, and we waited for five hours, perched on platforms in trees, without getting a shot, although we had been assured that pigs, babirúsas, and anóas would rush past us in dozens. I myself, with two men, staid three days longer to get more specimens of the maleos, and succeeded in preserving twenty-six very fine ones, the flesh and eggs of which supplied us with abundance of good food.

The major sent a boat, as he had promised, to take home

my baggage, while I walked through the forest with my two boys and a guide about fourteen miles. For the first half of the distance there was no path, and we had often to cut our way through tangled rattans or thickets of bamboo. In some of our turnings to find the most practicable route I expressed my fear that we were losing our way, as, the sun being vertical, I could see no possible clew to the right direction. My conductors, however, laughed at the idea, which they seemed to consider quite ludicrous; and sure enough, about half-way, we suddenly encountered a little hut where people from Licoupang came to hunt and smoke wild pigs. My guide told me he had never before traversed the forest between these two points; and this is what is considered by some travellers as one of the savage "instincts," whereas it is merely the result of wide general knowledge. The man knew the topography of the whole district — the slope of the land, the direction of the streams, the belts of bamboo or rattan, and many other indications of locality and direction; and he was thus enabled to hit straight upon the hut in the vicinity of which he had often hunted. In a forest of which he knew nothing he would be quite as much at a loss as a European. Thus it is, I am convinced, with all the wonderful accounts of Indians finding their way through trackless forests to definite points. They may never have passed straight between the two particular points before, but they are well acquainted with the vicinity of both, and have such a general knowledge of the whole country, its water system, its soil and its vegetation, that as they approached the point they are to reach, many easily-recognized indications enable them to hit upon it with certainty.

The chief feature of this forest was the abundance of rattan palms hanging from the trees, and turning and twisting about on the ground, often in inextricable confusion. One wonders at first how they can get into such queer shapes; but it is evidently caused by the decay and fall of the trees up which they have first climbed, after which they grow along the ground till they meet with another trunk up which to ascend. A tangled mass of twisted living rattan is therefore a sign that at some former period a large tree has fallen there, though there may be not the slightest vestige of it left. The rattan seems to have unlimited powers of growth, and a single plant may mount up several trees in succession, and thus reach the enormous length they are said sometimes to attain. They much improve the appearance of a forest as seen from the coast; for they vary the otherwise monotonous tree-tops with feathery crowns of leaves rising clear above them, and each terminated by an erect leafy spike like a lightning-conductor.

The other most interesting object in the forest was a beautiful palm, whose perfectly smooth and cylindrical stem rises erect to more than a hundred feet high, with a thickness of only eight or ten inches; while the fan-shaped leaves which compose its crown are almost complete circles of six or eight feet diameter, borne aloft on long and slender petioles, and beautifully toothed round the edge by the extremities of the leaflets, which are separated only for a few inches from the circumference. It is probably the *Livistona rotundifolia* of botanists, and is the most complete and beautiful fan-leaf I have ever seen, serving admirably for folding into water-buckets and *impromptu* baskets, as well as for thatching and other purposes.

A few days afterward I returned to Menado on horseback, sending my baggage round by sea, and had just time to pack up all my collections to go by the next mail-steamer to Amboyna. I will now devote a few pages to an account of the chief peculiarities of the zoology of Celebes, and its relation to that of the surrounding countries.

* * *

The position of Celebes is the most central in the Archipelago. Immediately to the north are the Philippine islands; on the west is Borneo; on the east are the Molucca Islands; and on the south is the Timor group: and it is on all sides so connected with these islands by its own satellites, by small islets, and by coral reefs, that neither by inspection on the map nor by actual observation around its coast is it possible to determine accurately which should be grouped with it, and which with the surrounding districts. Such being the case, we should naturally expect to find that the productions of this central island in some degree represented the richness and variety of the whole Archipelago, while we should not expect much individuality in a country so situated that it would seem as if it were pre-eminently fitted to receive stragglers and immigrants from all around.

As so often happens in nature, however, the fact turns out to be just the reverse of what we should have expected; and an examination of its animal productions shows Celebes to be at once the poorest in the number of its species, and the most isolated in the character of its productions of all the great islands in the Archipelago. With its attendant islets, it spreads over an extent of sea hardly inferior in length and breadth to that occupied by Borneo, while its actual land area is nearly double that of Java; yet its Mammalia and terrestrial birds number scarcely more than half the species found in the last-named island. Its position is such that it could receive immigrants from every side more readily than Java, yet in proportion to the species which inhabit it far fewer seem derived from other islands, while far more are altogether peculiar to it; and a considerable number of its animal forms are so remarkable, as to find no close allies in any other part of the world. I now propose to examine the best known groups of Celebesian animals in some detail, to study their relations to those of other islands, and to call attention to the many points of interest which they suggest.

We know far more of the birds of Celebes than we do of any other group of animals. No less than 191 species have been discovered, and though no doubt many more wading and swimming birds have to be added, yet the list of land birds, 144 in number, and which for our present purpose are much the most important, must be very nearly complete. I myself assiduously collected birds in Celebes for nearly ten months, and my assistant, Mr. ALLEN, spent two months in the Sula Islands. The Dutch naturalist FORSTEN spent two years in Northern Celebes (twenty years before my visit), and collections of birds had also been sent to Holland from Macassar. The French ship of discovery *L'Astrolabe* also touched at Menado and procured collections. Since my return home, the Dutch naturalists ROSENBERG and BERNSTEIN have made extensive collections both in North Celebes and in the Sula Islands; yet all their researches combined have only added eight species of land birds to those forming part of my own collection — a fact which renders it almost certain that there are very few more to discover.

Besides Salayer and Boutong on the south, with Peling and Bungay on the east, the three islands of the Sula (or Zula) Archipelago also belong zoologically to Celebes, although their position is such that it would seem more natural to group them with the Moluccas. About 48 land birds are now known from the Sula group, and if we reject from these five species which have a wide range over the Archipelago, the remainder are much more characteristic of Celebes than of the Moluccas. Thirty-one species are identical with those of the former island, and four are representatives of Celebes forms, while only eleven are Moluccan species, and two more representatives.

But although the Sula Islands belong to Celebes, they are so close to Bouru and the southern islands of the Gilolo group, that several purely Moluccan forms have migrated there, which are quite unknown to the island of Celebes itself; the whole thirteen Moluccan species being in this category, thus adding to the productions of Celebes a foreign element which does not really belong to it. In studying the peculiarities of the Celebesian fauna, it will therefore be well to consider only the productions of the main island.

The number of land birds in the island of Celebes is 128, and from these we may, as before, strike out a small number of species which roam over the whole Archipelago (often from India to the Pacific), and which therefore only serve to disguise the peculiarities of individual islands. These are 20 in number, and leave 108 species which we may consider as more especially characteristic of the island. On accurately comparing these with the birds of all the surrounding countries, we find that only nine extend into the islands westward, and nineteen into the islands eastward, while no less than 80 are entirely confined to the Celebesian fauna — a degree of individuality which, considering the situation of the island, is hardly to be equalled in any other part of the world. If we still more closely examine these 80 species, we shall be struck by the many peculiarities of structure they present, and by the curious affinities with distant parts of the world which many of them seem to indicate. These points are of so much interest and importance that it will be necessary to pass in review all these species which are peculiar to the island, and to call attention to whatever is most worthy of remark.

Six species of the hawk tribe are peculiar to Celebes; three of these are very distinct from allied birds which range

over all India to Java and Borneo, and which thus seem to be suddenly changed on entering Celebes. Another (*Accipiter trinotatus*) is a beautiful hawk, with elegant rows of large round white spots on the tail, rendering it very conspicuous and quite different from any other known bird of the family. Three owls are also peculiar; and one, a barn owl (*Strix rosenbergii*), is very much larger and stronger than its ally *Strix javanica*, which ranges from India through all the islands as far as Lombock.

Of the ten parrots found in Celebes, eight are peculiar. Among them are two species of the singular racquet-tailed parrots forming the genus *Prioniturus*, and which are characterized by possessing two long spoon-shaped feathers in the tail. Two allied species are found in the adjacent island of Mindanao, one of the Philippines, and this form of tail is found in no other parrots in the whole world. A small species of lorikeet (*Trichoglossus flavoviridis*) seems to have its nearest ally in Australia.

The three woodpeckers which inhabit the island are all peculiar, and are allied to species found in Java and Borneo, although very different from them all.

Among the three peculiar cuckoos two are very remarkable. *Phœnicophaus callirhynchus* is the largest and handsomest species of its genus, and is distinguished by the three colors of its beak, bright yellow, red, and black. *Eudynamis melanorhynchus* differs from all its allies in having a jet-black bill, whereas the other species of the genus always have it green, yellow, or reddish.

The Celebes roller (*Coracias temmincki*) is an interesting example of one species of a genus being cut off from the rest. There are species of *Coracias* in Europe, Asia, and Africa, but none in the Malay Peninsula, Sumatra, Java, or Borneo. The present species seems therefore quite out of place; and, what is still more curious, is the fact that it is not at all like any of the Asiatic species, but seems more to resemble those of Africa.

In the next family, the bee-eaters, is another equally isolated bird (*Meropogon forsteni*), which combines the characters of African and Indian bee-eaters, and whose only near ally (*Meropogon breweri*) was discovered by M. DU CHAILLU in West Africa!

The two Celebes hornbills have no close allies in those which abound in the surrounding countries. The only thrush (*Geocichla erythronota*) is most nearly allied to a species peculiar to Timor. Two of the fly-catchers are closely allied to Indian species which are not found in the Malay Islands. Two genera somewhat allied to the magpies (*Streptocitta* and *Charitornis*), but whose affinities are so doubtful that Professor SCHLEGEL places them among the starlings, are entirely confined to Celebes. They are beautiful long-tailed birds, with black and white plumage, and with the feathers of the head somewhat rigid and scale-like.

Doubtfully allied to the starlings are two other very isolated and beautiful birds. One (*Enodes erythrophrys*) has ashy and yellow plumage, but is ornamented with broad stripes of orange-red above the eyes. The other (*Basilornis celebensis*) is a blue-black bird, with a white patch on each side of the breast, and the head ornamented with a beautiful compressed scaly crest of feathers, resembling in form that of the well-known cock-of-the-rock of South America. The only ally to this bird is found in Ceram, and has the feathers of the crest elongated upward into quite a different form.

A still more curious bird is the *Scissirostrum pagei*, which although it is at present classed in the starling family, differs from all other species in the form of the bill and nostrils, and seems most nearly allied in its general structure to the oxpeckers (*Buphaga*) of tropical Africa, next to which the celebrated ornithologist Prince BONAPARTE finally placed it. It is almost entirely of a slaty color, with yellow bill and feet, but the feathers of the rump and upper tail-coverts each terminate in a rigid glossy pencil or tuft of a vivid crimson. These pretty little birds take the place of the metallic-green starlings of the genus *Calornis*, which are found in most other islands of the Archipelago, but which are absent from Celebes. They go in flocks, feeding upon grain and fruits, often frequenting dead trees, in holes of which they build their nests, and they cling to the trunks as easily as woodpeckers or creepers.

Out of eighteen pigeons found in Celebes, eleven are peculiar to it. Two of them (*Ptilonopus gularis* and *Turacœna menadensis*) have their nearest allies in Timor. Two others (*Carpophaga forsteni* and *Phlœgenas tristigmata*) most resemble Philippine Island species, and *Carpophaga radiata* belongs to a New Guinea group. Lastly, in the gallinaceous tribe, the curious helmeted maleo (*Megacephalon rubripes*) is quite isolated, having its nearest (but still distant) allies in the brush-turkeys of Australia and New Guinea.

Judging, therefore, by the opinions of the eminent naturalists who have described and classified its birds, we find that many of the species have no near allies whatever in the countries which surround Celebes, but are either quite isolated, or indicate relations with such distant regions as New Guinea, Australia, India, or Africa. Other cases of similar remote affinities between the productions of distant countries no doubt exist, but in no spot upon the globe that I am yet acquainted with do so many of them occur together, or do they form so decided a feature in the natural history of the country.

The Mammalia of Celebes are very few in number, consisting of fourteen terrestrial species and seven bats. Of the former no less than eleven are peculiar, including two which there is reason to believe may have been recently carried into other islands by man. Three species, which have a tolerably wide range in the Archipelago, are — 1, the curious lemur (*Tarsius spectrum*), which is found in all the islands as far westward as Malacca; 2, the common Malay civet (*Viverra tangalunga*), which has a still wider range; and 3, a deer, which seems to be the same as the *Rusa hippelaphus* of Java, and was probably introduced by man at an early period.

The more characteristic species are as follow:

*Cynopithecus nigrescens*, a curious baboon-like monkey, if not a true baboon, which abounds all over Celebes, and is found nowhere else but in the one small island of Batchian, into which it has probably been introduced accidentally. An allied species is found in the Philippines, but in no other island of the Archipelago is there any thing resembling them. These creatures are about the size of a spaniel, of a jet-black color, and have the projecting dog-like muzzle and overhanging brows of the baboons. They have large red callosities and a short fleshy tail, scarcely an inch long and hardly visible. They go in large bands, living chiefly in the trees, but often descending on the ground and robbing gardens and orchards.

*Anóa depressicornis* (the Sapi-utan, or wild cow of the Malays) is an animal which has been the cause of much controversy, as to whether it should be classed as ox, buffalo, or antelope. It is smaller than any other wild cattle, and in many respects seems to approach some of the ox-like antelopes of Africa. It is found only in the mountains, and is said never to inhabit places where there are deer. It is somewhat smaller than a small Highland cow, and has long straight horns, which are ringed at the base, and slope backward over the neck.

The wild pig seems to be of a species peculiar to the island; but a much more curious animal of this family is the Babirúsa, or pig-deer, so named by the Malays from its long and slender legs, and curved tusks resembling horns. This extraordinary creature resembles a pig in general appearance, but it does not dig with its snout, as it feeds on fallen fruits. The tusks of the lower jaw are very long and sharp, but the upper ones, instead of growing downward in the usual way, are completely reversed, growing upward out of bony sockets through the skin on each side of the snout, curving backward to near the eyes, and in old animals often reaching eight or ten inches in length. It is difficult to understand what can be the use of these extraordinary horn-like teeth. Some of the old writers supposed that they served as hooks, by which the creature could rest its head on a branch. But the way in which they usually diverge just over and in front of the eye has suggested the more probable idea that they serve to guard these organs from thorns and spines while hunting for fallen fruits among the tangled thickets of rattans and other spiny plants. Even this, however, is not satisfactory, for the female, who must seek her food in the same way does not possess them. I should be inclined to believe rather that these tusks were once useful, and were then worn down as fast as they grew; but that changed conditions of life have rendered them unnecessary, and they now develop into a monstrous form, just as the incisors of the beaver or rabbit will go on growing, if the opposite teeth do not wear them away. In old animals they reach an enormous size, and are generally broken off as if by fighting.

Here again we have a resemblance to the wart-hogs of Africa, whose upper canines grow outward and curve up so as to form a transition from the usual mode of growth to that of the Babirúsa. In other respects there seems no affinity between these animals, and the Babirúsa stands

completely isolated, having no resemblance to the pigs of any other part of the world. It is found all over Celebes and in the Sula Islands, and also in Bouru, the only spot beyond the Celebes group to which it extends; and which island also shows some affinity to the Sula Islands in its birds, indicating, perhaps, a closer connection between them at some former period than now exists.

The other terrestrial mammals of Celebes are, five species of squirrels, which are all distinct from those of Java and Borneo, and mark the furthest eastward range of the genus in the tropics; and two of Eastern oppossums (*Cuscus*), which are different from those of the Moluccas, and mark the furthest westward extension of this genus and of the Marsupial order. Thus we see that the Mammalia of Celebes are no less individual and remarkable than the birds, since three of the largest and most interesting species have no near allies in surrounding countries, but seem vaguely to indicate a relation to the African continent.

Many groups of insects appear to be especially subject to local influences, their forms and colors changing with each change of conditions, or even with a change of locality where the conditions seem almost identical. We should therefore anticipate that the individuality manifested in the higher animals would be still more prominent in these creatures with less stable organisms. On the other hand, however, we have to consider that the dispersion and migration of insects is much more easily affected than that of mammals even of birds. They are much more likely to be carried away by violent winds; their eggs may be carried on leaves either by storms of wind or by floating trees, and their larvæ and pupæ, often buried in trunks of trees or inclosed in waterproof cocoons, may be floated for days or weeks uninjured over the ocean. These facilities of distribution tend to assimilate the productions of adjacent lands in two ways: first, by direct mutual interchange of species; and secondly by repeated immigrations of fresh individuals of a species common to other islands, which by intercrossing, tend to obliterate the changes of form and color, which differences of conditions might otherwise produce. Bearing these facts in mind, we shall find that the individuality of the insects of Celebes is even greater than we have any reason to expect.

For the purpose of insuring accuracy in comparisons with other islands, I shall confine myself to those groups which are best known, or which I have myself carefully studied. Beginning with the *Papilionidæ*, or swallow-tailed butterflies, Celebes possesses 24 species, of which the large number of 18 are not found in any other island. If we compare this with Borneo, which out of 29 species has only two not found elsewhere, the difference is as striking as any thing can be. In the family of the *Pieridæ*, or white butterflies, the difference is not quite so great, owing perhaps to the more wandering habits of the group; but it is still very remarkable. Out of 30 species inhabiting Celebes, 19 are peculiar, while Java (from which more species are known than from Sumatra or Borneo), out of 37 species has only 13 peculiar. The *Danaidæ* are large, but weak-flying butterflies, which frequent forests and gardens, and are plainly but often very richly colored. Of these my own collection contains 16 species from Celebes and 15 from Borneo; but whereas no less than 14 are confined to the former island, only two are peculiar to the latter. The *Nymphalidæ* are a very extensive group, of generally strong-winged and very bright-colored butterflies, very abundant in the tropics, and represented in our own country by our fritillaries, our *Vanessas*, and our Purple Emperor. Some months ago I drew up a list of the Eastern species of this group, including all the new ones discovered by myself, and arrived at the following comparative results:

| | Species of *Nymphalidæ* | Species peculiar to each Island | Percentage of peculiar Species |
|---|---|---|---|
| Java | 70 | 23 | 33 |
| Borneo | 52 | 15 | 29 |
| Celebes | 48 | 35 | 73 |

The *Coleoptera* are so extensive that few of the groups have yet been carefully worked out. I will therefore refer to one only, which I have myself recently studied — the *Cetoniadæ*, or rose-chafers, a group of beetles which, owing to their extreme beauty, have been much sought after. From Java 37 species of these insects are known, and from Celebes only 30; yet only 13, or 35 per cent., are peculiar to the former island, and 19, or 63 per cent., to the latter.

The result of these comparisons is, that although Celebes is a single large island with only a few smaller ones closely grouped around it, we must really consider it as forming one of the great divisions of the Archipelago, equal in rank and importance to the whole of the Moluccan or Philippine groups, to the Papuan Islands, or to the Indo-Malay islands (Java, Sumatra, Borneo, and the Malay Peninsula). Taking those families of insects and birds which are best known, the following table shows the comparison of Celebes with the other groups of islands:

| | PAPILIONIDÆ AND PIERIDÆ | HAWKS, PARROTS, AND PIGEONS |
|---|---|---|
| | Per cent. of peculiar Species | Per cent. of peculiar Species |
| Indo-Malay region | 56 | 54 |
| Philippine group | 66 | 73 |
| Celebes | 69 | 60 |
| Moluccan group | 52 | 62 |
| Timor group | 42 | 47 |
| Papuan group | 64 | 74 |

These large and well-known families well represent the general character of the zoology of Celebes; and they show that this island is really one of the most isolated portions of the Archipelago, although situated in its very centre.

But the insects of Celebes present us with other phenomena more curious and more difficult to explain than their striking individuality. The butterflies of that island are in many cases characterized by a peculiarity of outline which distinguishes them at a glance from those of any other part of the world. It is most strongly manifested in the *Papilios* and the *Pieridæ*, and consists in the fore wings being either strongly curved or abruptly bent near the base, or in the extremity being elongated and often somewhat hooked. Out of the 14 species of *Papilio* in Celebes, 13 exhibit this peculiarity in a greater or less degree, when compared with the most nearly allied species of the surrounding islands. Ten species of *Pieridæ* have the same character, and in four or five of the *Nymphalidæ* it is also very distinctly marked. In almost every case the species found in Celebes are much larger than those of the islands westward, and at least equal to those of the Moluccas, or even larger. The difference of form is however the most remarkable feature, as it is altogether a new thing for a whole set of species in one country, to differ in exactly the same way from the corresponding sets in all the surrounding countries; and it is so well marked, that without looking at the details of coloring, most Celebes *Papilios* and many *Pieridæ*, can be at once distinguished from those of other islands by their form alone. . . .

From the analogy of birds, we should suppose that the pointed wing gave increased rapidity of flight, since it is a character of terns, swallows, falcons, and of the swift-flying pigeons. A short and rounded wing, on the other hand, always accompanies a more feeble or more laborious flight, and one much less under command. We might suppose, therefore, that the butterflies which possess this peculiar form were better able to escape pursuit. But there seems no unusual abundance of insectivorous birds to render this necessary; and as we can not believe that such a curious peculiarity is without meaning, it seems probable that it is the result of a former condition of things, when the island possessed a much richer fauna, the relics of which we see in the isolated birds and Mammalia now inhabiting it; and when the abundance of insectivorous creatures rendered some unusual means of escape a necessity for the large-winged and showy butterflies. It is some confirmation of this view, that neither the very small nor the very obscurely colored groups of butterflies have elongated wings, nor is any modification perceptible in those strong-winged groups which already possess great strength and rapidity of flight. These were already sufficiently protected from their enemies, and did not require increased power of escaping from them. It is not at all clear what effect the peculiar curvature of the wings has in modifying flight.

Another curious feature in the zoology of Celebes is also worthy of attention. I allude to the absence of several groups which are found on both sides of it, in the Indo-Malay islands as well as in the Moluccas, and which thus seem to be unable, from some unknown cause, to obtain a footing in the intervening island. In birds we have the two families of *Podargidæ* and *Laniadæ*, which range over the whole Archipelago and into Australia, and which yet have no representative in Celebes. The genera *Ceyx* among kingfishers, *Criniger* among thrushes, *Rhipidura* among flycatchers, *Calornis* among starlings, and *Erythrura* among

finches, are all found in the Moluccas as well as in Borneo and Java, but not a single species belonging to any one of them is found in Celebes. Among insects, the large genus of rose-chafers (*Lomaptera*) is found in every country and island between India and New Guinea except Celebes. This unexpected absence of many groups from one limited district in the very centre of their area of distribution, is a phenomenon not altogether unique, but, I believe, nowhere so well marked as in this case; and it certainly adds considerably to the strange character of this remarkable island.

The anomalies and eccentricities in the natural history of Celebes which I have endeavored to sketch in this chapter all point to an origin in a remote antiquity. The history of extinct animals teaches us, that their distribution in time and in space are strikingly similar. The rule is, that just as the productions of adjacent areas usually resemble each other closely, so do the productions of successive periods in the same area; and as the productions of remote areas generally differ widely, so do the productions of the same area at remote epochs. We are therefore led irresistibly to the conclusion, that change of species, still more of generic and of family form, is a matter of time. But time may have led to a change of species in one country, while in another the forms have been more permanent, or the change may have gone on at an equal rate, but in a different manner in both. In either case the amount of individuality in the productions of a district will be to some extent a measure of the time that district has been isolated from those that surround it. Judged by this standard, Celebes must be one of the oldest parts of the Archipelago. It probably dates from a period not only anterior to that when Borneo, Java, and Sumatra were separated from the continent, but from that still more remote epoch when the land that now constitutes these islands had not risen above the ocean. Such an antiquity is necessary, to account for the number of animal forms it possesses, which show no relation to those of India or Australia, but rather with those of Africa; and we are led to speculate on the possibility of there having once existed a continent in the Indian Ocean which might serve as a bridge to connect these distant countries. Now it is a curious fact that the existence of such a land has been already thought necessary, to account for the distribution of the curious *Quadrumana* forming the family of the Lemurs. These have their metropolis in Madagascar, but are found also in Africa, in Ceylon, and in the peninsula of India, and in the Malay Archipelago as far as Celebes, which is its furthest eastern limit. Dr. SCLATER has proposed for the hypothetical continent connecting these distant points, and whose former existence is indicated by the Mascarene Islands and the Maldive coral group, the name of *Lemuria*. Whether or no we believe in its existence in the exact form here indicated, the student of geographical distribution must see in the extraordinary and isolated productions of Celebes, proofs of the former existence of some continent from whence the ancestors of these creatures, and of many other intermediate forms, could have been derived.

In this short sketch of the most striking peculiarities of the natural history of Celebes, I have been obliged to enter much into details that I fear will have been uninteresting to the general reader, but unless I had done so my exposition would have lost much of its force and value. It is by these details alone, that I have been able to prove the unusual features that Celebes presents to us. Situated in the very midst of an Archipelago, and closely hemmed in on every side by islands teeming with varied forms of life, its productions have yet a surprising amount of individuality. While it is poor in the actual number of its species, it is yet wonderfully rich in peculiar forms; many of which are singular or beautiful, and are in some cases absolutely unique upon the globe. We behold here the curious phenomenon of groups of insects changing their outline in a similar manner when compared with those of surrounding islands, suggesting some common cause which never seems to have acted elsewhere in exactly the same way. Celebes, therefore, presents us with a most striking example of the interest that attaches to the study of the geographical distribution of animals. We can see that their present distribution upon the globe is the result of all the more recent changes the earth's surface has undergone; and by a careful study of the phenomena we are sometimes able to deduce approximately what those past changes must have been, in order to produce the distribution we find to exist. In the comparatively simple case of the Timor group we were able to deduce these changes with some approach to certainty. In the much more complicated case of Celebes, we can only indicate their general nature, since we now see the result, not of any single or recent change only, but of whole series of the later revolutions which have resulted in the present distribution of land in the eastern hemisphere.

# THE PUZZLE OF PITHECANTHROPUS

*by*

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On December 16, 1940, Professor EUGÈNE (MARIE FRANÇOIS THOMAS) DUBOIS died at his home in Haarlem at the age of 82 years. One of the most important and surprising discoveries in the history of paleoanthropology will forever remain connected with his name. After four years of paleontological research work in Sumatra and Java (1889–1893), DUBOIS published, in 1894, his first monograph on *Pithecanthropus erectus:* "Eine menschenähnliche Übergangsform aus Java," as the title reads. At that time *Pithecanthropus erectus* was represented by a skull cap, a third upper molar and a femur, all recovered in 1891 and 1892 from the left bank of the Bengawan (Solo) River near Trinil. The three skeletal parts described in the paper "certainly derive from a creature which represents an evolutionary stage intermediate between anthropoids and man," says DUBOIS and "considering the small distance between the individual spots where the three finds were made it would be preposterous to doubt that they belonged to the same individual." Although DUBOIS at once recognized the similarity of the skull cap to that of man, on the one hand, and to the anthropoids, on the other, he did not risk comparison with that of Neanderthal man, at that time known by the skull caps of Düsseldorf and Spy. Without any reservations he accepted the strange ideas of R. VIRCHOW whom he quotes, that the bones of Düsseldorf and Spy are from "pathologically deformed individuals" and "the race to which they belonged is morphologically not less developed than recent mankind."

This tragic prejudice which he held at the very start of his anthropological career and from which he never freed himself hampered him in seeing the issues as long as he lived. In addition,

* *Original contribution especially prepared for "Science and Scientists in the Netherlands Indies."*

certain likenesses of the Trinil skull cap to those of the gibbon impressed DUBOIS to such an extent that he believed in a closer relationship between this ape and *Pithecanthropus* than any he felt could exist between *Pithecanthropus* and chimpanzee. In his first publication DUBOIS did not advance beyond this point. Only later did he come out with his own idea according to which *Pithecanthropus* must be considered as a true gibbon, although a giant and somewhat transformed one, and, for this reason, no direct connections with either anthropoids or man could exist. Even after the discovery of *Sinanthropus pekinensis* which released *Pithecanthropus* from the morphological isolation in which DUBOIS had placed him, he refused to make any concession in this regard. In August 1938, I visited DUBOIS at the Museum in Leyden and enjoyed the great privilege of being shown the whole *Pithecanthropus* material and of having DUBOIS himself explain it. In return I made him acquainted with some interesting specimens of the *Sinanthropus* material in which he showed a great interest. Nevertheless, he was very reticent in discussing the problem of the relationship between the two types. Some months later I received a letter in which he accepted my classification of *Sinanthropus* as the most primitive hominid, so far known, but he scrupulously avoided mentioning *Pithecanthropus* in this connection. Apparently he still stuck to his old idea, regarding *Pithecanthropus* as a quite different and unique primate from which no direct line leads to man.

DUBOIS' conclusions with regard to the classification of *Pithecanthropus*, as set forth in his first publication, met with a divided reception. While some critics accepted the gibbon thesis, but without acknowledging the intermediate evolutionary character of *Pithecanthropus*, others regarded the fossil as a true hominid. There was the same discrepancy of opinions with regard to the nature of the femur and tooth, and whether they belonged to the same individual or at least to the same type, as that represented by the skull. The critics agreed only in one point: in general shape, proportions and details, the femur appeared to be so like that of modern man that it could hardly have belonged to a skull which had such small capacity and so pronouncedly ape-like features. If DUBOIS were right, the "missing link," the discovery of which he claimed, was a reality; for here we have before us a human femur and a skull very similar to that of an ape, combined in one individual. Although this was not exactly the kind of missing link of which anthropologists had dreamed, it could at least pass as such.

Some new light on the *Pithecanthropus* problem was shed by the discovery of Peking man. The archaic form of the *Sinanthropus* skull with those characteristic features, lowness of the brain case, receeding forehead, heavy and far-projecting frontal and occipital tori combined with relatively small cranial capacity, has its counterpart in the skull cap of Trinil. However, the *Sinanthropus* skulls are more complete than the fragmentary *Pithecanthropus* skull, and there can be no doubt that they are those of true hominids. The likeness between the two, therefore, makes it evident that *Pithecanthropus*, too, must be considered a hominid. Some years before the first *Sinanthropus* skull was discovered, the German anthropologist WEINERT tried to reconstruct the Trinil brain case after having studied the original material and having noted the main landmarks essential for such an attempt. On the basis of his restoration WEINERT arrived at the conclusion that the Trinil skull is the skull of a hominid although inferior to any of the known Neanderthalians. Indeed, the measurements of the restored skull agree, in some cases with surprising accuracy, with those of the later found *Sinanthropus* skull.

There was still another problem which was brought closer to its solution through the *Sinanthropus* discovery. The excavations in Choukoutien not only provided us with skulls of *Sinanthropus* but also with a great many teeth, some isolated, some still embedded in the jaws, and finally with some femora which, although incomplete, gave a satisfactory idea of size, form and proportions of the lower limb.

The upper molar, a third right one, which DUBOIS had recorded as found in the immediate neighborhood of the skull cap and had, therefore, attributed to *Pithecanthropus*, had raised suspicion early that it could not be the tooth of a gibbon-like primate or even of a hominid. Its resemblance to the molar of the living orang-utang suggested that it might really be an orang tooth and its association with the *Pithecanthropus* skull a purely accidental one. A second upper molar, not mentioned in DUBOIS' report of 1894 but listed as a *Pithecanthropus* tooth in the author's later publication (1924), met with the same fate. The reason was that DUBOIS first attributed the second tooth, found at a distance of some three meters from the original position of the skull cap, to a *Cynocephalus:* yet there is practically no difference between this tooth and the first one. The *Sinanthropus* upper molars are not only smaller than DUBOIS' alleged *Pithecanthropus* molars but also show a quite different pattern and one much more human.

Although the newly discovered Peking man neither lent support to DUBOIS' theory of the ape-character of *Pithecanthropus* nor to his claim that all the Trinil specimens belonged to the same individual, or at least to the same type, it did show the femur question in a new light. The *Sinanthropus* femur is certainly shorter than the Trinil femur. There are also some peculiarities in which it does not conform to the latter. On the whole, however, it turned out to be a characteristic, human femur with no definite signs of a real approach either to an anthropoid or gibbon femur. And this in spite of the primitive character of the *Sinanthropus* skull and teeth. Since this was so, why then could not the Trinil femur also belong to the Trinil skull cap?

The *Pithecanthropus* problem began to take another turn when Dr. RALPH VON KOENIGSWALD took the matter in hand. After DUBOIS' return to Holland, in 1895, nobody seemed inclined to follow his lead. Fossil man in Java was as dormant as he was before DUBOIS' arrival. Even the courageous expedition of Mrs. E. SELENKA in 1907–1908 proved a complete failure from the view-point of paleoanthropology. It did not bring any new human material to light — except for a worn tooth of questionable provenance and nature, and it was unable to draw the attention of the scientific world to this special spot for a second time. All the credit that this negligence finally gave way to keen interest, growing from year to year, must go to

VON KOENIGSWALD's initiative and energy. VON KOENIGSWALD's credit is all the greater because his work was done almost as a hobby, without much more than benevolent toleration on the part of his superiors, and with very limited financial support, first granted by the Carnegie Institution of Washington through its then president, Dr. JOHN C. MERRIAM, and later supplemented by the Cenozoic Research Laboratory in Peiping with the consent of the Rockefeller Foundation in New York.

Three important discoveries, each following the other in a short space of time, mark the beginning of the new era. They were remarkable also in so far as they came from sites which had previously yielded only animal bones. The first specimen, recovered in 1936, was, surprisingly enough, the calvaria of a child which can hardly have been more than two years of age. There can be no doubt that this is a human skull. Although diagnosis as to the particular type is very difficult because of its immature state, it can be said with certainty that the skull belongs to a primitive hominid form. VON KOENIGSWALD gave the non-committal name of "Homo modjokertensis" to it, leaving doubt, by this ambiguous appellation, as to whether we have a *Pithecanthropus* baby before us or one of another, so far unknown human form. To complicate the matter still more, the skull was dug from a site far away from Trinil, at Modjokerto near Soerabaja in East Java, and from strata which underlie the Trinil formation and has been named Djetis bed. The geological facts, therefore, seem to indicate that the skull, in spite of the fragile character of those infantile bones, represents a type geologically older than the hominid from Trinil. If, however, the Modjokertensis skull is identical with the Trinil form, *Pithecanthropus* must reach down from the Trinil into the next lower period.

The next specimen, recovered in 1937, was from a new site, the Sangiran district near Soerakarta, but this time it was from a horizon with the same fauna as that of Trinil; this specimen was the fragment of a lower jaw. The four teeth which were preserved, the exposed, empty sockets of three more and the character of the bone, left no doubt that the jaw belongs to a hominid which must have had a small, man-like canine and a first pre-molar also of man-like character. As the specimen was found in a typical Trinil formation VON KOENIGSWALD attributed it to *Pithecanthropus* and called it *Pithecanthropus Mandible B.*

The third specimen, recovered in 1938, and again coming from the Trinil bed of Sangiran, is a skull. This skull is astonishingly like DUBOIS' skull cap from Trinil in general form as well as in some characteristic structures and, therefore, undoubtedly represents the same type, namely *Pithecanthropus*. But it differs from the Trinil cap in one decisive point. It is more complete, for essential parts of the base are preserved, and this makes certainty of what was at first deemed only a probability. *Pithecanthropus*, so far as he is represented by these two skulls of Trinil (Skull I) and Sangiran (Skull II), is a true hominid and corresponds to about the same evolutionary stage as *Sinanthropus*. As the Sangiran skull is smaller than the Trinil one although both are adult and relatively old, to judge from the condition of the cranial sutures, it seemed safe to consider the larger one as a male and the smaller one as a female.

The position of the baby skull of Modjokerto remained unaffected by the new discoveries but it is another matter with the lower jaw of Sangiran (Mandible B). This mandible is of about the same size and proportions as the male *Sinanthropus* mandible G I. Therefore, it provided evidence that the same proportions between size of skull and size of jaw are valid in both *Pithecanthropus* and *Sinanthropus*, and proved itself too large for either of the known *Pithecanthropus* skulls. Another difficulty arises. The first discovery of a human skeletal part which DUBOIS ever made on Java's soil was that of a small fragment of a lower jaw with the broken root of one tooth (first premolar) in situ. DUBOIS found this piece in 1890 in the so-called Kendeng deposits, not very far from Trinil. But he did not return to a study of this bone until 1924. Then he described it as the mandible of Kedung Brubus and attributed it to *Pithecanthropus* (later called by VON KOENIGSWALD and myself Mandible A). However, this mandible is not only considerably smaller than the Sangiran Mandible B but differs from it in the very peculiar conformation of the lower margin, in particular of the digastric fossa. While the Sangiran mandible agrees in this respect with all known hominid mandibles including those of *Sinanthropus*, the Kedung Brubus mandible is entirely different. The character of the fossa distinguishes it not only from any fossil or recent human forms but from fossil and recent anthropoids also. On the other hand, there seems to be no question as to the human character of the fragment in spite of its small size. If DUBOIS did not hesitate to list the Kedung-Brubus jaw among the remains of *Pithecanthropus*, this classification can be done with far more justification for the Sangiran mandible of 1937.

Additional discoveries, still more surprising than the earlier ones, were made by VON KOENIGSWALD but they brought no solution to the old *Pithecanthropus* problem. On the contrary, they complicated it more and more. One of the discoveries was the fragment of a juvenile skull cap which was found in 1938. During my stay in Java, I was able to recognize this as a typical *Pithecanthropus* and called it Skull III. It seemed to serve as corroboration that all human bones deriving from Trinil beds, regardless of special site, belong to DUBOIS' *Pithecanthropus erectus*. However, the next find, made in 1939, did not seem to fit too well into this picture. This new find was an almost complete upper jaw and the greater part of a brain case with forehead and face missing (Fig. 102). Like the mandible and the second and third skull caps it came from the Trinil beds of Sangiran. The misfortune is that the parts preserved are crushed and the fragments partly dislocated so that only a restricted use can be made of the specimen. But what has remained is sufficient to determine the character of the skull with certainty. It is the skull of a true hominid, the intact occipital region of the braincase shows a great resemblance to that of *Pithecanthropus* although it differs from the Trinil and Sangiran skulls in some very characteristic features. The braincase is larger and much more massive and heavier. The so-called sagittal crest which crowns the braincases of *Sinanthropus* and, to a lesser extent, of *Pithecanthropus* like the "lophos" of the ancient Greek helmet, is very pronounced. But in this new braincase

the crest does not consist of a continuous keel-like ridge but rather of a chain of more or less isolated knobs.

Certain features of the maxilla are still more unusual for a hominid. The upper canines, both of which are well preserved, have the same form and size as those of *Sinanthropus* and are, therefore, quite different from any anthropoid canine; but there is a broad gap (diastema) on either side between the canines and the lateral incisors. Furthermore, the second upper molar is considerably larger than the first and third ones. In addition the palate is completely smooth and carries no rugosities. Finally, the maxilla is much longer and broader than any known human jaw, fossil or recent. There is no doubt that all these peculiarities are either typical simian features which have never before been encountered in any hominid skull, or they represent, as for example, the strange sagittal crest, a novelty for man and apes.

When VON KOENIGSWALD and I — the preparation of this skull was carried out at the Cenozoic Research Laboratory in Peiping — were first confronted with this skull and its distinctive characteristics, we were dubious as to its true *Pithecanthropus* nature. But we set our doubts at rest by consoling ourselves with the fact that the original *Pithecanthropus* had no upper jaw available for comparison and that all of the most conspicuous of the existing differences might be due to differences in sex. The Trinil skull (I) and the Sangiran skull (II) could, we believed, be considered as females. Consequently, the new skull which we called *Pithecanthropus* Skull IV was regarded as a male in which case its heavy character, opposed to the gracile one of the earlier skulls, could find a satisfactory explanation. But this complacency did not last long.

Some months after the discovery of this skull a piece of a lower jaw with some teeth was picked up again from the Trinil bed in the Sangiran district. In spite of its fragmentary condition with the consequent obscurity of the characters of its dentition, the jaw showed clearly that it was neither of the same kind as the *Pithecanthropus* Mandible B nor of the Kedung Brubus Mandible A. Both it and the teeth are considerably larger than even the first one. There are some features which bear a resemblance to the jaw of an orang-utang but others which point rather in the direction of hominids. The trouble is that, for the time being, nothing but a cast is available, and the war has discontinued any communication with Java. The definite verdict on this specimen must, therefore, be postponed. But whatever the final verdict may be, the jaw certainly represents a type somehow intermediate between anthropoid and man yet not identical with *Pithecanthropus erectus*.

Finally, in 1941 — that is to say so far as we have heard of what has happened in this special field in Java — VON KOENIGSWALD found another fragment of a lower jaw, also with some teeth (Figs. 103 a–f; 104 a–d). This, as proved by

FIGURE 102. — *Pithecanthropus robustus* (Skull IV). RECONSTRUCTION IN THREE QUARTERS PROFILE. ×½. The reconstructed parts in lighter color. The lower jaw is a reconstruction of the *Pithecanthropus* Mandible 1937 (B) adjusted to Skull IV.

the character of the teeth and certain specific features, is, without doubt, the mandible of a true hominid. But both bone and teeth far exceed in massiveness and size all fossil human forms as well as all living anthropoids. This jaw is not much higher than that of the biggest male gorilla (Fig. 103d) but it is considerably thicker (Fig. 104c). It is of course much larger and much more massive than *Pithecanthropus* mandible B (Fig. 103b). Since the big "male" *Pithecanthropus* Skull IV has no mandible, direct comparison is impossible. But it is evident that the new mandible must have belonged to a skull is also more archaic than that of any other fossil hominid — the *Pithecanthropus* Mandible B included.

A giant hominid with characteristics undoubtedly more primitive than any one known is a surprising novelty in itself. But this latest discovery provides a clue leading to the explanation of the other hominid forms which the Trinil beds have yielded and which have been attributed to *Pithecanthropus* regardless of their apparent structural differences. So far we have four mandibles: (1) the mandible of Kedung Brubus; (2) the *Pithecanthropus* Mandible B;

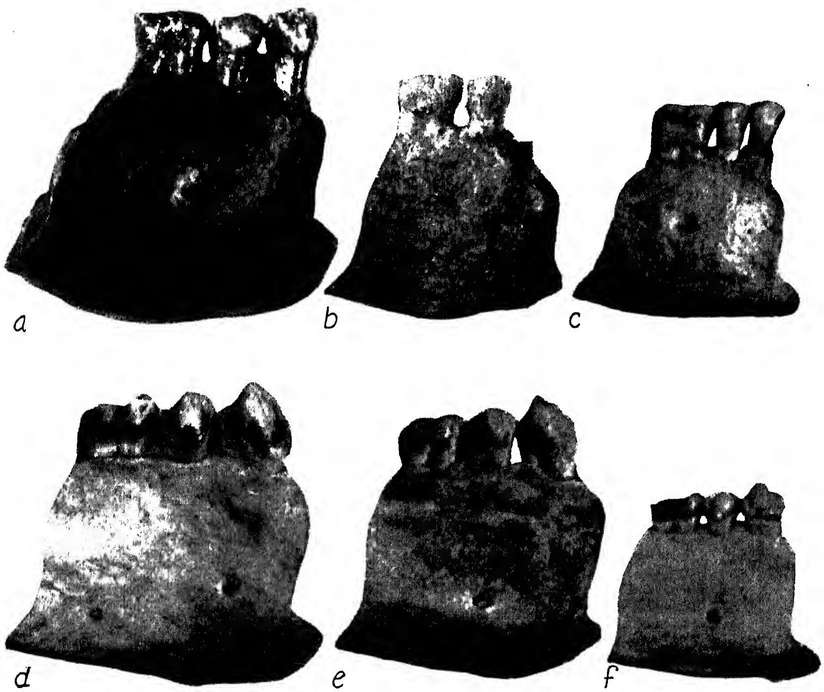


FIGURE 103. — MANDIBLE FRAGMENT OF *Meganthropus palaeojavanicus* von Koenigswald (*a*) compared with the same portion of *Pithecanthropus*. Mandible B (*b*), modern man (*c*), male gorilla (*d*), male orang-utang (*e*), and male chimpanzee (*f*). All about × ⅘. Lateral (buccal) view. — The picture shows the difference in size of bone and teeth, the conformity among the hominid types (*a, b, c*) and their dissimilarities from the anthropoids (*d, e, f*).

much larger than Skull IV. This implies that this new hominid type as compared with recent man or with the known fossil forms was of gigantic size. VON KOENIGSWALD himself recognized the giant character, for a letter from Ir. W. C. B. KOOLHOVEN, Director of the Geological Survey of the Netherlands Indies, advising that the casts had been mailed, announced that VON KOENIGSWALD called the type "*Meganthropus palaeojavanicus*." In assigning this name he acknowledges, at once, that the mandible differs from *Pithecanthropus* in its main characters. Such a classification is all the more justified since the giant jaw possesses some peculiarities which clearly indicate that it is of a more primitive character. In one of these, the formation of the digastric fossa, the jaw even approaches one of the fossil anthropoids, *Dryopithecus fontani*. The shape of the dental arch (3) the mandible of Sangiran found in 1939 which is, for the present, undeterminable; and (4) the mandible of *Meganthropus*. Each of these is larger than the preceding. Even if the mandible of 1939 is set aside because of its questionable character, there remains *Pithecanthropus* Skull IV, the upper jaw of which indicates that the lower one must have been smaller than the *Meganthropus* mandible but larger than the *Pithecanthropus* Mandible B. This strange sequence in size reveals a clear tendency toward gigantism and proves that the enormous size of the *Meganthropus* mandible is not an isolated phenomenon but rather a definite step in a determined line of evolution.

That there must have been a real strain of gigantism in the line of human ancestry has been proved by another discovery which we owe, once more, to the passionately inquiring mind

of Dr. R. VON KOENIGSWALD. In searching for fossil teeth in the Chinese apothecary-shops of Hong Kong, he came across a right lower molar of a primate of colossal dimensions. The tooth was worn but nevertheless VON KOENIGSWALD was able to recognize it as the tooth of a primate evidently high in the classificatory scale. He described it (1935) as the molar of an unknown anthropoid and gave the type the name "*Gigantopithecus blacki.*" Later he acquired a second tooth, in the same way. This was an upper molar, only slightly worn. Later still he came into possession of a third tooth, another third lower molar but a left one this time, which showed no sign of attrition. All three teeth have one peculiarity in common; their roots are broken off at the neck. Only in the last of the three is the posterior root preserved. This fact, together with the circumstance that they were picked up in an apothecary-shop in Hong Kong where they were among teeth of *Stegodon*, tapir, orang-utang and other mammals, all of which had been deprived of their roots, offers an unfailing clue as to their provenance. We know from the research work of TEILHARD DE CHARDIN, YOUNG, PEI, and CHANG (1935) that teeth, whose roots have been gnawed off by porcupines, and skeletal elements of the same fauna are characteristic of the fauna which have been recovered from the so-called "yellow deposits" in certain caves of South China. The deposits and the bones they contain belong to the Middle Pleistocene, or possibly to the Lower Pleistocene. *Gigantopithecus*, so far known only from Chinese chemists' shops in Hong Kong, is apparently a member of this fauna. This fauna, however, is not restricted to South China but is the same as the Trinil fauna of Java. VON KOENIGSWALD and others have therefore called it the "Sino-Malayan fauna." Although *Gigantopithecus* has not shown up, so far, in Java itself, it is safe to say that it is closely connected with the Trinil fauna.

This, however, is not the whole story. The essential point is the recognition that *Gigantopithecus* is not an anthropoid as assumed by VON KOENIGSWALD but a true hominid (Fig. 105). (This is not the place to enter upon a discussion of this special point, the interested reader is referred to my forthcoming paper.) In spite of their enormous size the teeth show a typical human pattern which is quite different from that of any recent or fossil anthropoid. Besides this, some details of the pattern actually ap-

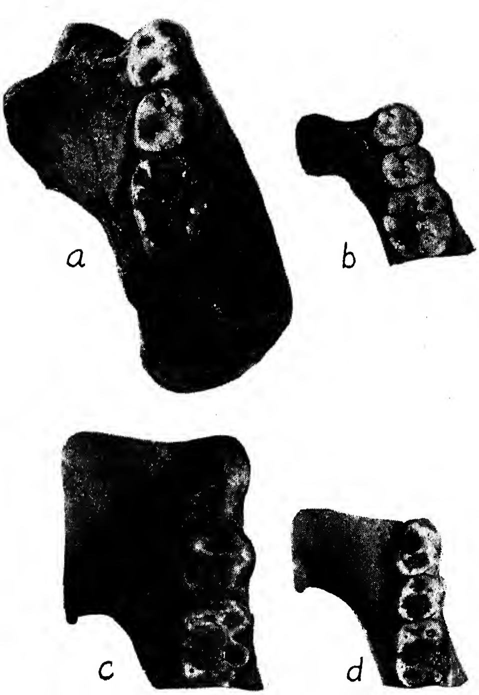


FIGURE 104. — MANDIBLE FRAGMENT of *Meganthropus palaeojavanicus* von Koenigswald (*a*) compared with the same portion of modern man (*b*), male gorilla (*c*), and male chimpanzee (*d*). All about × 5/6. Viewed from above (occlusal surface).

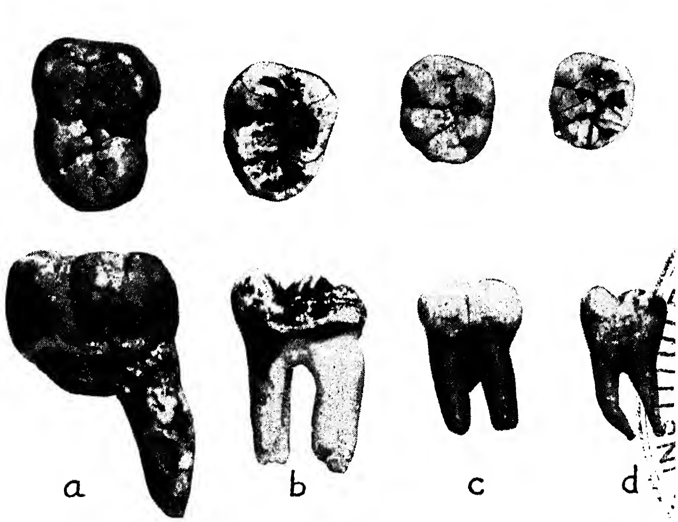


FIGURE 105. — LOWER MOLAR OF *Gigantopithecus* (*a*), male gorilla (*b*), *Sinanthropus pekinensis* (*c*), recent man (Amerindian) (*d*). Upper row in occlusal view, lower row viewed from the buccal side. All in natural size.

proach more closely to the pattern of modern man than do even the teeth of *Sinanthropus* which, till *Gigantopithecus* came to light, was the most archaic hominid tooth of which we had knowledge. On the other hand, there are certain features, in particular the length and shape of the lower molar, which must be considered as an indication of a very primitive stage of evolution.

*Gigantopithecus*, which has been misnamed and should be called "*Gigantanthropus*" if only the iron rule of scientific nomenclature would allow it, represents the climax in the evolutionary stages of the Southeast Asiatic hominids, so far as size is concerned. The upper surfaces of the crowns both of upper and lower molars are three times larger than those of modern man; more than one-third larger than the molars of *Meganthropus* as calculated on the basis of the size of the preserved molar; and even a good deal larger than the maximum recorded for the male gorilla. The size of the skull or the body-size of an individual or type cannot be computed with certainty on the basis of size of teeth alone. Nevertheless, it is safe to say that *Gigantopithecus* must have been much bigger and taller than the biggest gorilla on record especially when account is taken of the fact that, as a hominid, he certainly had a much longer femur than a gorilla has. I shall return to this question later. As to *Meganthropus*, the size of its mandible and teeth which have been preserved give an approximate idea of the size of body we may expect. He was a giant not merely when gauged by the stature-standard of modern man but when measured by that of the recent gorilla.

Turning back to *Pithecanthropus*, it seems evident that not only DUBOIS but also VON KOENIGSWALD and I were mistaken in thinking that each fossil bone of human appearance picked up from the Trinil bed must be a *Pithecanthropus*, or, in other words, a type having hominid character in general but with some simian traits. We know now that these beds lodge a great variety of forms similar to each other but with morphological peculiarities distinct enough to distinguish each sharply when we try to understand their true nature and relationships. As the matter stands now this is a very difficult task. For the material available for such an analysis is very heterogeneous and most specimens are not directly comparable. We have all together four mandible fragments; three more or less fragmentary adult skulls when the infantile skull of Sangiran and the baby skull of Modjokerto are not counted in; one femur and two (or three) isolated teeth. But we have not the skulls which belong to the mandibles nor have we the mandibles which belong to the skulls. We are, therefore, confined to inferences which all bear the hazard of the situation. But one thing is evident: If the Trinil skull cap (Skull I) is accepted as DUBOIS' holotype of *Pithecanthropus erectus*, only the Sangiran skull cap of 1938 (Skull II) and the infantile skull from the same locality (Skull III) can be classified as the same type. The massive "male" skull of Sangiran with the maxilla, designated as Skull IV, already showing a tendency toward gigantism, must be placed in a separate group. I propose for it the name "*Pithecanthropus robustus*." In the case of the mandibles the classification is much more difficult. The biggest of all has been singled out by VON KOENIGSWALD in giving his type the proper name "*Meganthropus palaeojavanicus*." In doing this he rightly acknowledged that this giant form was to be distinguished from *Pithecanthropus*. According to the letter of Dr. W. C. KOOLHOVEN, mentioned earlier, VON KOENIGSWALD considered the dubious Sangiran mandible of 1939, which I failed to identify with any known type because of its defective condition, as the female form of *Meganthropus*. I am unable to agree with him because these two differ from each other in fundamental structures which cannot be pushed aside by taking the easiest way out and explaining them as differences of sex. There is no precedent for such an occurrence. Whether this mandible belongs to *Pithecanthropus* or represents a type of its own can only be decided when the original is available. But in this case it is also necessary that we be quite clear as to what is to be regarded as a *Pithecanthropus* mandible. DUBOIS who ascribed the jaw of Kedung Brubus to *Pithecanthropus* had no other justification for such an attribution but the fact that the jaw was picked up from a Trinil bed. That cannot be accepted as a convincing criterion, particularly as this mandible deviates from all known hominid mandibles. The Sangiran mandible of 1937 corresponds much more closely to what we would expect the lower jaw of the Trinil or Sangiran skull cap to be (Skulls I and II), in spite of the fact that it is actually too large for either. Considering the fact that this Sangiran mandible bears the closest resemblance to the *Sinanthropus* mandible; considering that the same is true of the *Pithecanthropus* Skulls I and II and the *Sinanthropus* skull; I do not feel that I am going far astray for the present in considering the Sangiran mandible of 1937 as the mandible type of *Pithecanthropus erectus* and the Kedung Brubus jaw as doubtful.

The two isolated upper molars found by DUBOIS together with the Trinil skull cannot be accepted as hominid teeth. Their form and pattern entirely conforms with those of an orang-utang, as I mentioned earlier. On the other hand, the maxilla of the Sangiran skull which I have assigned to *Pithecanthropus robustus* shows how the upper molars of such a true hominid as *Pithecanthropus* really look. Their pattern is a typical human one, quite different from that of DUBOIS' Trinil teeth.

Despite all the help given by these new discoveries in elucidating some of the most doubtful points in the *Pithecanthropus* question, no progress was made with regard to the Trinil femur. Its association with the skull cap, DUBOIS' reason for attributing it to *Pithecanthropus*, has been proved fallacious. So far no other femur, against which DUBOIS' could be checked, has been secured from the Trinil beds. It is true that, in 1932, DUBOIS proclaimed the discovery of no less than five additional femora which he claimed as belonging to *Pithecanthropus*. These femora, mingled with ribs and other non-identifiable long-bones of mammals, were found in a box stored in the attic of the museum in Leyden. According to DUBOIS, "the new femora of *Pithecanthropus erectus* were found in a collection of fossil bones acquired from excavations executed at Trinil in 1900." Quite apart from the character of these bones, nobody will accept the label on the box as sufficient proof that they belong to *Pithecanthropus*, especially as we have discovered how many different types can be

TABLE I. LIST OF SKELETAL PARTS OF HOMINID FORMS RECORDED FROM TRINIL BEDS:—

| SPECIMEN | YEAR OF DISCOVERY | SITE | WHEN AND BY WHOM RECOGNIZED? | ATTRIBUTED TO | ALLEGED GENERAL ZOOLOGICAL CHARACTER | LATER REFERRED TO AS | REVISED CLASSIFICATION |
|---|---|---|---|---|---|---|---|
| MANDIBLE | 1890 | Kedung-Brubus | DUBOIS, 1924 | *Pithecanthropus erectus* | giant gibbon (intermediate) | Mandible A | hominid: possibly *Pithecanthropus erectus* |
| TOOTH (RIGHT $M^3$) | 1891 | Trinil | DUBOIS, 1894 | *Pithecanthropus erectus* | giant gibbon (intermediate) | ...................... | not human, orang-utang |
| SKULL CAP | 1891 | Trinil | DUBOIS, 1894 | *Pithecanthropus erectus* | giant gibbon (intermediate) | *Pithecanthropus* Skull I | hominid: *Pithecanthropus erectus* Skull I |
| LEFT FEMUR | 1892 | Trinil | DUBOIS, 1894 | *Pithecanthropus erectus* | giant gibbon (intermediate) | Trinil femur | hominid: *Pithecanthropus? Homo sapiens?* |
| TOOTH (LEFT $M^2$) | 1892 | Trinil | DUBOIS, 1924 | *Pithecanthropus erectus* | giant gibbon (intermediate) | ...................... | not human, orang-utang |
| TOOTH (LEFT P) | 1898? | Trinil | DUBOIS, 1924 | *Pithecanthropus erectus* | giant gibbon (intermediate) | ...................... | hominid: *Pithecanthropus? Homo sapiens?* |
| FIVE FEMORA | 1900 | Trinil (?) | DUBOIS, 1932-1935 | *Pithecanthropus erectus* | giant gibbon (intermediate) | Leyden femora | hominid: *Pithecanthropus? Homo sapiens?* |
| MANDIBLE | 1937 | Sangiran | v. KOENIGSWALD, 1937 | *Pithecanthropus erectus* | hominid | Mandible B | hominid: *Pithecanthropus erectus* |
| SKULL CAP | 1938 | Sangiran | v. KOENIGSWALD, 1938 | *Pithecanthropus erectus* | hominid | *Pithecanthropus* Skull II | hominid: *Pithecanthropus erectus* Skull II |
| SKULL FRAGMENT | 1938 | Sangiran | v. KOENIGSWALD and WEIDENREICH, 1938 | *Pithecanthropus erectus* | hominid | *Pithecanthropus* Skull III | hominid: *Pithecanthropus erectus* Skull III |
| SKULL CAP AND MAXILLA | 1939 | Sangiran | v. KOENIGSWALD and WEIDENREICH, 1939 | *Pithecanthropus erectus* | hominid | *Pithecanthropus* Skull IV, male | hominid: *Pithecanthropus robustus* Weidenreich |
| MANDIBLE | 1939 | Sangiran | v. KOENIGSWALD, 1941 | *Meganthropus palaeojavanicus*, female | hominid | *Meganthropus*, female | indeterminable: hominid? anthropoid? |
| MANDIBLE | 1941 | Sangiran | v. KOENIGSWALD, 1941 | *Meganthropus palaeojavanicus*, male | hominid | *Meganthropus*, male | hominid: *Meganthropus palaeojavanicus* von Koeni swald |

covered by the label: Trinil. In addition, none of these femora agrees in size, form or proportion with the original Trinil femur. However, one fact is sure; these bones show all the characteristics of hominid femora but do not approach those of the gibbon or any anthropoid. Although the matter stands now where it stood fifty years ago, one very essential detail, at least, has been cleared up. The general human character of the femur alone cannot serve as a denial that it belongs to a primitive skull such as those found in the Trinil beds. For we now know that *Sinanthropus* which has a skull with similar archaic structures, nevertheless possesses a femur with more advanced features. DUBOIS called *Pithecanthropus "erectus"* because he deduced from the length and the proportions of the Trinil femur, the erect posture of the creature to whom it belonged. That he was right in this conclusion in spite of the debatable nature of the femur follows from the skull of *Pithecanthropus robustus* in which the base is preserved. This reveals that the occipital foramen occupies a central position similar to that in recent man and in all fossil hominids. There is no rearward shift such as is exhibited by anthropoids which walk, more or less, on all fours. Yet the great question still remains in abeyance, waiting for future discoveries. Will these show that the femora of all hominid forms yielded by the Trinil beds are as entirely like those of modern man as is DUBOIS' Trinil femur? Or will the future show some femora with evidently primitive details which may eliminate the first found, stamping it definitely as the femur of a modern man accidentally mixed with other primitive skeletal elements?

We can take it as surely ascertained that not one but several primitive hominid types are buried in the sand and ashes of the Trinil formation. In order to facilitate the following survey a list (Table I) recording all the specimens recovered from Trinil beds has been added with the data referring to site, time of discovery, character, previous and definite classifications. So far as a verdict, based on material both available and reliable, is possible at present, there are: first, a form which DUBOIS called *Pithecanthropus erectus;* then, a form which I have called *Pithecanthropus robustus;* and finally, a third type called by VON KOENIGSWALD *Meganthropus palaeojavanicus.* DUBOIS' mandible of Kedung Brubus and VON KOENIGSWALD'S Sangiran mandible of 1939 cannot be classified now; nor can DUBOIS' femur from Trinil. As to the relationship which the recognized types bear to each other, it is absolutely necessary to know whether the morphologic differences have the character of mere group variations within the same evolutionary stage of development or whether they are to be regarded as the expression of different phylogenetic stages. I consider the latter alternative the right one, as I have set forth on the preceding pages. This view holds good without any reservation whatever so far as *Meganthropus* is concerned. This is not because it is a giant type — an argument of which the significance will be discussed later — but because the jaw certainly reveals undoubtedly archaic features which are not merely wanting in the *Pithecanthropus* mandible of 1937 but which are not even indicated. As to *Pithecanthropus robustus,* the decision is more difficult because his most characteristic structures cannot be tested against *Pithecanthropus erectus* since the corresponding skeletal parts are not preserved in the latter. However, what is left for comparison points in the same direction. The morphological sequence of the forms, recognized as hominids, recovered from the Trinil beds is, therefore, as follows; *Meganthropus, Pithecanthropus robustus, Pithecanthropus erectus.* To which of these forms the baby skull of Modjokerto belongs cannot be told without a thorough investigation, but also in this case the answer will probably remain doubtful because of the infantile character of the specimen.

It has become almost a rule in paleoanthropology that when a new hominid type is recovered scarcely one is proclaimed as lying in the line which leads to modern man. The type is usually held to be a representative of an extinct side-branch with no bearing on the problem of the ancestry of "Homo sapiens." I do not share this prejudice. As I have repeatedly shown elsewhere there is not the slightest justification for all those claims. They are completely arbitrary and based on purely subjective impressions. We do not know of any morphological criterion which testifies the generic specificity of any hominid form which, so far, has come to light. All that has been brought forward on this point has been based on merely geological considerations. It is argued that this or that type cannot be ancestral to another because it was found in the same geological horizon, or in one so close to it that there was no time for transformation. Or, it is said, a type which appears morphologically more primitive has been recovered from a younger geological formation than the more advanced form; or conversely.

How do the geological data stand in the case of the hominids from the Trinil beds? DUBOIS first believed that the Trinil formation was Upper Pliocene but today there is agreement among the experts that it belongs to the Middle Pleistocene. If this is true, all the hominids recovered from the Trinil beds, regardless of whether they represent more primitive or more advanced types, are of the same geological period. Only the baby skull of Modjokerto must be discarded because it was found in the Djetis formation which underlies the Trinil and is, therefore, of Lower Pleistocene age. Hence, the Modjokerto skull could serve as an indicator of time if only it were possible to determine which of the hominid types it represents. No doubt is admissible that the human fossils with which we are dealing have been dug or picked from the Trinil beds. But quite another question is the matter as to whether the different types they represent lived in the same geological period. All the skeletal parts are fragmentary and apparently broken before fossilization set in. Some of the pieces show signs of having been rolled or weathered. The matrix in which they are embedded consists of a mixture of volcanic ashes and sand, packed together so that it is evident that the bones, or rather the fragments of bones, had been transported by mud streams over longer or shorter distances before coming to rest in the place where they were found. There is even the possibility that such transportation did not happen once but several times. The stratigraphic conditions and the formation of the Sangiran and Trinil sites have been discussed by DE TERRA (1943). VON KOENIGSWALD'S Sangiran Skull of 1938 (*Pithecanthropus erectus*) comes from the

bank of the Tjemoro River and, according to DE TERRA, especially from a layer of "sand with fine pebble layers and cross-bedding." "The constituents are well waterworn and consist of volcanic rocks typical of the Merapi region from which the river descends." The horizon "represents a fluvial deposit laid down in a shifting stream channel . . . The river carried a great deal of volcanic material, ashes as well as lapilli; in addition it must have picked up a great many bones of land fauna which populated the foothills of the great volcanic range in the south." The conditions of the Trinil site from which DUBOIS' skull cap was recovered are still more obscure. DE TERRA arrives at the same conclusion: "the questions of whether there has not been some redeposition in the Trinil horizon during Late Pleistocene or even post-Pleistocene times demands further field study." As to the character of the special horizons where the skull of *Pithecanthropus robustus* and the mandible of *Meganthropus* were picked up, we are completely in the dark. But it can be supposed that the conditions do not differ in principle from those of the Sangiran site which yielded the *Pithecanthropus erectus* skull.

Taking all this into consideration, the geological data, so far as they are known at present, give no evidence as to the age of the different hominid types. They may have lived contemporaneously; but with equal justification it can be assumed that they lived in different geological periods and that their bones were later accidentally deposited in the same geological formation. But even their contemporaneity would not necessarily exclude any relationship either ascendant or descendant. Therefore, *Meganthropus* can well be ancestral to *Pithecanthropus robustus* and *Pithecanthropus robustus* ancestral to *Pithecanthropus erectus*, as the morphological facts suggest. Gigantism then may well have been a primary hominid condition and the tendency to decrease in size would go hand in hand with the evolutionary progress and the differentiation in the direction of modern man.

Here is where *Gigantopithecus* comes into the picture. There is little doubt that the hominids of Java, whichever type may have been the most primitive, cannot have developed in Java itself because Java is a relatively young settling-place for primates. They must have migrated from the mainland in company with the fauna with which they are associated. As was said earlier, the "Sino-Malayan fauna" had its original seat in South East Asia during the Lower and Middle Pleistocene. *Gigantopithecus* is apparently the continental hominid representative of this fauna but its presence in Java is, so far, not noted. On the other hand, there is no evidence that a type like *Meganthropus* or *Pithecanthropus robustus* lived on the continent of Asia. The only primitive hominid known from this area is *Sinanthropus*. *Sinanthropus*, however, is a more advanced type than *Meganthropus* and *Pithecanthropus robustus* and more nearly corresponds to the evolutionary stage of *Pithecanthropus erectus*. *Gigantopithecus* may, therefore, be the ancestor of the Java line of hominids as well as of their North Asian line. Gigantism in the ancestry of the Java hominids furnishes also the simplest explanation for the extraordinary size and robustness of some of the *Homo soloensis* skulls. As I have shown elsewhere (1943) these skulls discovered by W. F. F. OPPENOORTH, in 1932, on a terrace of the Solo River, are morphologically more advanced than *Pithecanthropus* but less so than the various forms of the Neanderthal group. They can most appropriately be interpreted as *Pithecanthropus* types with enlarged braincases and some structural differences due to this transformation. Geologically, the skulls belong to the Notopoero beds, overlying the Trinil beds, and consequently Upper Pleistocene. It seems difficult to trace these skulls back to an ancestral form of such small size and relatively gracile appearance as showed by the *Pithecanthropus erectus* skulls. But if skulls like *Pithecanthropus robustus* or *Meganthropus*, having apparent gigantic traits, are in the ancestral line, this difficulty is overcome. The Rhodesian skull and the Heidelberg mandible bear witness that gigantism may also have played a rôle in the ancestry of African and European hominids. Yet I dare not pretend that smaller forms may not already have existed at the time of *Gigantopithecus* and that also these smaller forms may have given origin to more advanced, smaller types.

All these and other questions must be left to the future. And this future obviously lies, so far as the material is concerned, in Java. There we have, not only the most primitive hominid forms ever found but several types of these, not one alone. It is evident also that these several types constitute a true evolutionary line. However, in Java we have not only primitive types but also more advanced ones, such as the type represented by *Homo soloensis*, which is closer to the Neanderthal stage. Finally there is the Wadjak man who, in spite of all the uncertainty still adhering to this find, is an archaic form of modern man, morphologically connected with the primitive hominid stages of Java, on the one hand, and with the Australian aborigines, on the other. There is no spot in the whole world where such an abundance of different forms is assembled and where, in addition, they are so easily accessible. Whether the puzzle which still involves *Pithecanthropus* can be definitely solved or at least further cleared, depends much less on the hazards of subject and locality than on our readiness and willingness to tackle the task.

In any case, it is the work of EUGÈNE DUBOIS which called attention to this remote place where no one before had any thought of undertaking such a fantastic task as deliberately digging for the ancestors of mankind. The obituary note in *Nature* (1941) in which Sir ARTHUR KEITH appraised DUBOIS' achievements, written at a time when the newest and most exciting discoveries were still unknown, closes with the following words: "The cemetery of fossil man which was discovered and exploited by Dr. DUBOIS in Java has proved to be rich beyond any other in every respect — rich in actual numbers and in types which preserve details of the sequence of humanity that has flitted across the time stage of Java these millions of years past. The series begins as ape-men and ends in the aboriginal type of modern Australian. Only in this Australo-Malayan part of the world is the evolutionary history of man known with any degree of fullness, and for this we are chiefly indebted to Dr. EUGÈNE DUBOIS."

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# A SHORT HISTORY OF GENERAL BOTANY IN THE NETHERLANDS INDIES

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The history of Botany in the Netherlands East Indies is naturally divided into periods, marked by the foundation of the Government Botanic Gardens at Buitenzorg in 1817, and the year 1880 when MELCHIOR TREUB assumed Directorship of this institution.

Prior to 1817 botanical research was not pursued in an organized way. Two great botanists, namely G. E. RUMPHIUS (1628–1702) and H. A. VAN RHEEDE VAN DRAAKESTEIN (1637–1691), had collected and described the plants of the Moluccas and of British India. Both being pre-Linnean, their contributions are not generally known, but up to the present time RUMPHIUS' descriptions of economic plants with his notes concerning their use are consulted.

In the 17th and 18th centuries Botany in the Indies did not reach beyond purely taxonomic work. The botany professors at the Universities in the Netherlands took part in the description and publication of the materials collected in the Indies. This one-sided development is not surprising, since botanists were busy making a botanical inventory of the world, before they could start to devote time to other endeavors.

When in 1815 the Netherlands East Indies were returned to Dutch rule, the Government immediately assumed full responsibility for investigating and developing the natural riches of the Indies. In 1816 the Amsterdam professor of Botany, C. G. C. REINWARDT (1773–1854), arrived in Java as Director of Agriculture, Arts and Sciences. During his six years' stay he did much to further these branches, but his most important work was the establishment of a Government Botanic Garden at Buitenzorg. This step must be considered more revolutionary than it appears to us at present. Prior to 1800 all botanic gardens were connected with Universities. In earlier times they had served not only for teaching but also as sources of material for the description of plants and as a depository of types. Later herbaria took over the latter two functions, so that by 1817 Botanic Gardens in general seemed to have their most useful period behind them, and their only function seemed closely connected with a university. The revival of interest in Botanic Gardens and their change in function during the last half century has been demonstrated by a few gardens, of which the one in Buitenzorg was among the most important.

According to REINWARDT's ideas the Gardens should "not only serve to grow many plants which are indigenous to our colony, but one will be able in them to test provisionally the cultiva-

* Parts of this account have been reprinted from "Science in the Netherlands East Indies," p. [illegible] *seq.* (Amsterdam: Kon. Ak. Wet., I.C.O. Committee, 1929).


FIGURE 106. — AN EARLY DUTCH REPRESENTATION OF A PALM (*Corypha?*) AND SOME IMPORTANT FRUIT TREES (*Michelia champaca* and *Artocarpus heterophylle*). — *From* "De eerste Schipvaerd der Hollandsche Natie naer Oost-Indien . . ." *in* "Begin ende Voortgangh van de Vereenighde Nederlantsche Geoctroyeerde Oost-Indische Compagnie" (1646). — *Courtesy Arnold Arboretum of Harvard University.*

tion of many other economic plants," and in addition the Gardens "will be usable as a nursery and distribution point of plants, which are required from here by botanic gardens and similar institutions in various regions and in Holland." On May 18, 1817 the first spade was put in the ground of the Buitenzorg Gardens and this signified the beginning of a new period in the scientific development of the Netherlands East Indies, primarily in the field of Botany, but also of Zoology, Agronomy and Horticulture. The Gardens themselves, with their Director, became the center of botanical study in the Asiatic Tropics.

Until 1822 REINWARDT was Director of the Gardens. When he left for Holland, C. L. BLUME (1792–1862) became his successor; but he stayed only four years. The first nine years of the young Gardens under these two energetic and able directors were very fruitful. Hundreds of plants became known and were described, hundreds of others were imported and grown in the Gardens. Simultaneously the "Biological Commission" with such enthusiastic and capable botanical members as H. KUHL (1797–1821), J. C. VAN HASSELT (1797–1823), P. W. KORTHALS (1807–1892), and A. ZIPPELIUS (1797–1828) made numerous expeditions all through the Indies to study flora, fauna, and geology. Large collections were brought together, so that the eighteen-twenties were a period of feverish botanical activity. For many decades to come botanists in Holland were busy describing the collected material.

Unfortunately this good beginning was interrupted: wars in Java and in Europe necessitated drastic cuts in the budget, so that no director of the Botanic Gardens was appointed to succeed BLUME. For forty years the Gardens were under the direct supervision of Army Officers in charge of the Palace of the Governor General, and the practical running was left in the hands of a curator or chief gardener. Only the fact that from 1831 on the latter position was in the hands of J. E. TEYSMANN (1808–1882), a most capable man of strong character, prevented the complete obliteration of the Buitenzorg Botanic Gardens as a scientific institution, for strong forces were pitted against it.

The gardens under TEYSMANN grew rapidly as the catalogues showed, and especially the collection of trees as it is today is mainly the result of his efforts. He was also very active in importing economic plants from other parts of the world. As collaborators he got men like J. K. HASSKARL (1811–1894) and S. BINNENDIJK (1821–1883).

In 1868 finally a new director of the Botanic Gardens was appointed, ending the long interregnum under the Intendant of the Palace of the Governor General. The new director, R. H. C. C. SCHEFFER (1844–1880), was very active, and under him the Gardens were not only guided in purely botanic direction, but an increasing interest in practical problems and agriculture became evident. Because of lack of space a new garden for economic plants was established nearby, and among the earliest introductions in this "Cultuurtuin" were the first *Hevea* trees to be brought to Java.

The upswing of the Gardens started under SCHEFFER, and grew into the most glorious development ever witnessed by any botanic garden under the directorship of MELCHIOR TREUB (1851–1910). He was not only a great botanist and scientist, but also a great organizer with a commanding personality. After twenty-five years of his directorship the Gardens had grown into such an enormous organization, with ramifications in practically all fields of Botany, Agriculture, Horticulture and Zoology, that in 1905 by a mere change in name the Divisions of the Gardens were reconstituted into a full-fledged Department of Agriculture, with TREUB as the first Director of Agriculture. In that way the Botanic Gardens became a division of the Department and after TREUB's return to Europe they were reconstituted as a research institute, but with all applied research detached.

J. C. KONINGSBERGER (1867– ) became director of the Buitenzorg Botanic Gardens in 1910 and had under him all laboratories of pure research, in both the botanical and zoological fields. In the course of the following years it became more and more evident that this complete separation of pure and applied research was not desirable. It tended to draw lines where no real barriers existed, and it dissociated the Botanic Gardens from those ventures which had given them their main impetus of development, and they fell back to the same status as most botanic gardens. During the last years this mistake was remedied, and through a complete reorganization of all research institutions, both pure and applied, under one directorate, the rift between pure and applied research was bridged again, and a period of renewed vigorous botanical activity, which was cut short by the Japanese invasion, was anticipated.

The botanic gardens themselves cover an area of 205 acres and are for the greater part an arboretum, in which the trees have been arranged in accordance with the natural plant-system. The gardens also contain a part for annuals and perennials and one for climbing plants. Then there is the so-called forest garden where, as far as possible, the conditions of a tropical primeval forest are imitated, and where forest plants can be studied in their natural surroundings. Besides these there are the lath-houses where orchids, ferns, etc., are grown. It is impossible to give a detailed description of these famous gardens in a few pages. For that matter every visitor can wander about them with the help of a guidebook, which is to be had in the Gardens.

It might be stressed that in the first place, the gardens serve as a scientific institution so that attention to their outward appearance has only been paid so far as this was compatible with the requirements of science. Yet there are a good many spots famous for their beauty, such as the Avenue of *Canarium* trees, the large lake, the various ponds in the lower-lying parts of the gardens, etc.

The great importance of the Gardens is due to the systematic arrangement of the plants as mentioned above, which was carried through by the curator J. E. TEYSMANN at the advice of HASSKARL, and is not found on such a large scale in any other tropical botanic garden. The Gardens owe their fame also to the excellent opportunities to study there, offered by the various laboratories, which are open to students from all countries.

A branch of the Gardens in Buitenzorg, described in the articles of DOCTERS VAN LEEUWEN and DAMMERMAN on p. 409 and p. 404, is in Tjibodas, situated on the slopes of the volcano Gedeh.

A few decades ago another branch of the bo-

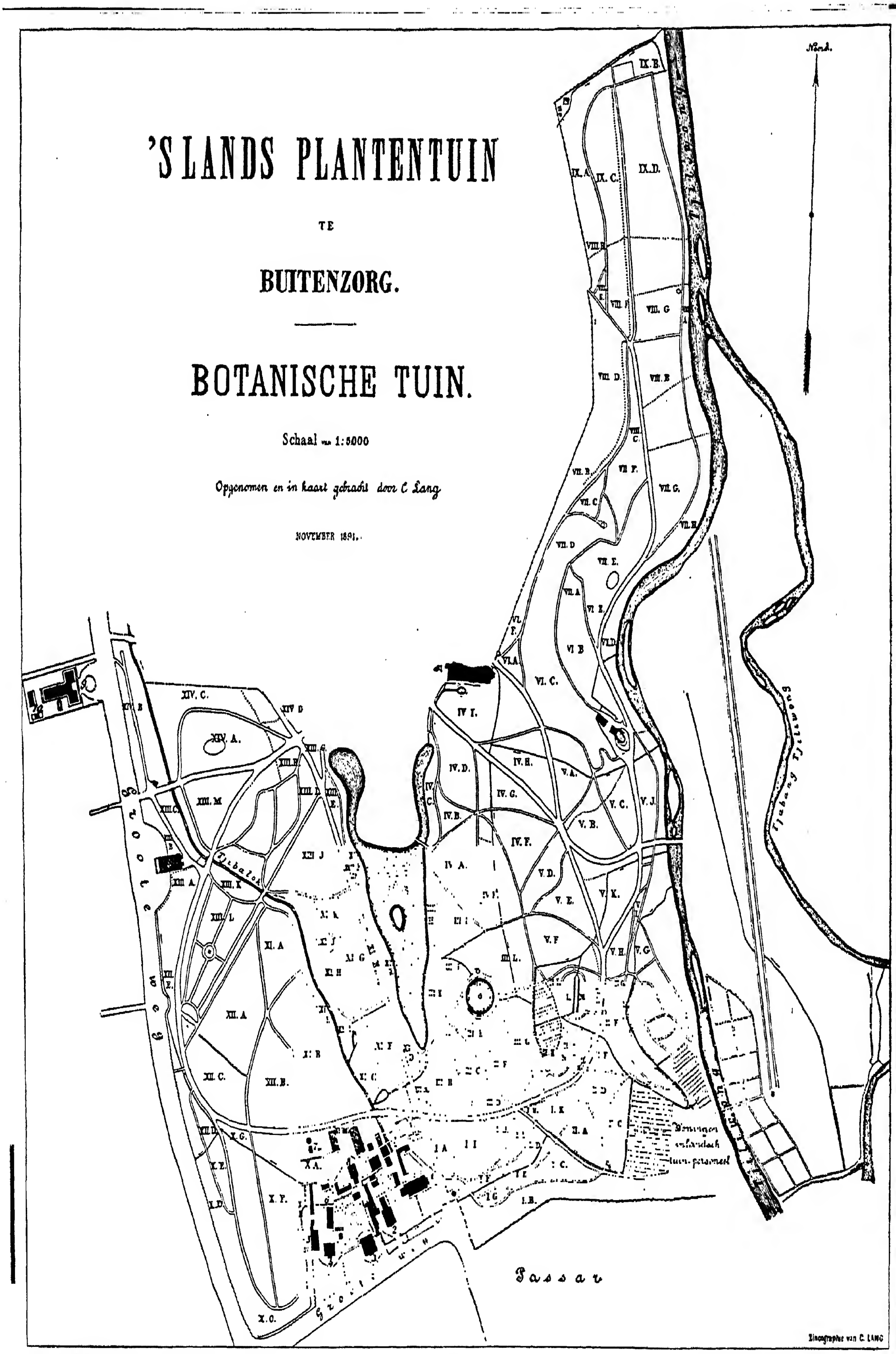


FIGURE 107.— THE GOVERNMENT BOTANIC GARDENS ('s Lands Plantentuin) IN 1891.— 1, Director's Residence; 2, Curator's Residence; 3, Offices and Laboratory; 4, Botanical Artist's Residence; 5, Photographic Laboratory; 6, Main Botanical Laboratories; 9, Botanical Museum; 10, Pharmacological Laboratory.

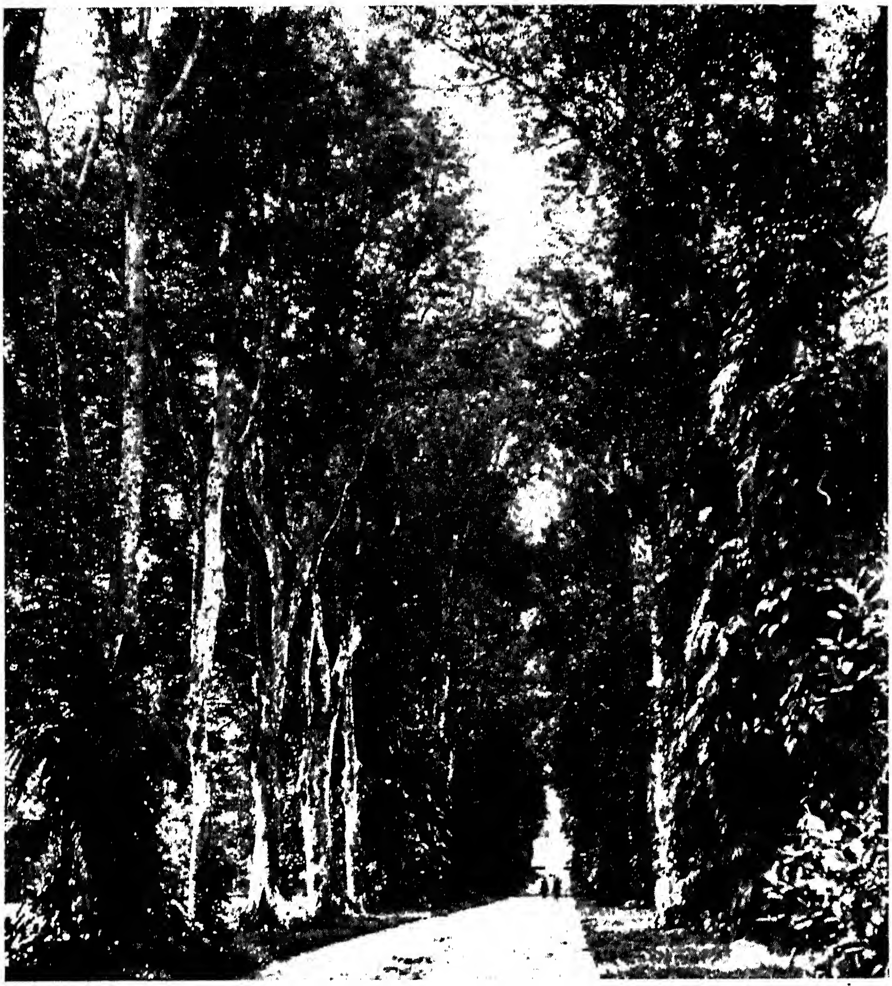

FIGURE 108. — THE FAMOUS OLD *Canarium* AVENUE IN THE GOVT. BOTANIC GARDENS, BUITENZORG *(Courtesy Arnold Arboretum of Harvard University)*. — The trunks of *Canarium commune* are covered by climbers, chiefly various *Araceae*, and epiphytes.

tanic gardens was established at the fisheries experiment station at Batavia. Mangroves and in general plants from the seashore are grown there under their normal conditions; it has also a laboratory for research work.

Hundreds of botanists from all over the world have visited the Gardens, and many of them have stayed for weeks or months to study special problems, or to become acquainted with the special plants and problems of the tropics. There were four main reasons why Buitenzorg became the Mecca of all botanists: 1) The rich collection of plants in the gardens, and the accessibility of low-land and mountain forests. 2) The personality of TREUB, whose fame as botanist and interpreter of tropical botany had spread everywhere. 3) A series of monographs on the lower and higher plants to be found in the neighborhood of Buitenzorg made an orientation in the flora easy for a visitor. 4) In 1884 a special laboratory was equipped to receive all visitors. This laboratory, formerly called the "Foreigners' Laboratory," was renamed "Treub Laboratory" in 1914 when it was housed in a new and modern building. A tabulation of the visitors of this Treub Laboratory shows that most were Netherlands biologists, many of whom were enabled to make a trip to Buitenzorg by an endowed fellowship. Similar endowments existed also in some other countries.

Consequently botanical research work in the Netherlands East Indies has by no means been done by Dutchmen exclusively and the results of this work have been published in periodicals of the whole world. The greater part, however, is found in the Garden's own periodical: the "Annales du Jardin Botanique de Buitenzorg." The first volume, edited by SCHEFFER, appeared in 1876; it contains only articles on taxonomy and plant geography. As many as nine years afterwards, the second volume, edited by TREUB, appeared, and since then the periodical has appeared regularly; its contents cover the whole field of botany. With a few English periodicals it is at present no doubt the most important peri-


FIGURE 109. — A VIEW IN BUITENZORG (Botanic Gardens and Palace of the Governor General), after a water colour by DOUGLAS HOUGHTON CAMPBELL, Ph.D., Ll.D., Professor Emeritus of Stanford University. Professor CAMPBELL visited the Malayan Archipelago repeatedly. He has published several important papers on the comparative anatomy of Javanese archegoniatae.

odical for the knowledge of general botany of the tropics.

Another publication published by the Botanic Gardens is the "Bulletin du Jardin Botanique." This contains all taxonomic publications by the staff of the Herbarium and collaborators. It is mainly a series of monographs of the most important families producing timber in the Netherlands East Indies. In addition it contains contributions concerning the geographical distribution of plants in the Asiatic tropics. The results of research work performed by foreigners are partly found in the Annales mentioned before, but also elsewhere; mention must be made here of the "Botanische Mitteilungen aus den Tropen," edited by A. F. W. SCHIMPER. It would be utterly impossible to mention other periodicals in these pages.

It need hardly be said that every botanist in the Netherlands East Indies will be struck first by the extremely luxuriant vegetation, especially as these investigators usually come from Europe or rather from countries belonging to the temperate zones. But in still another respect, the plants of the tropics differ greatly from what is observed about those of Europe, North America and Japan. TREUB was the first to point out that the plants there all hibernate and that consequently the physiology of plants which is based on observations in Europe might be compared with a physiology of animals based on observations about marmots. There is some truth in this, though TREUB's statement is not without exaggeration. It is true that such a thing as a winter-sleep is something unknown in the Indies, but for all that certain times of rest in the vegetation also occur there. Investigators have to a certain extent been led astray by the more or less exceptional climate of Buitenzorg. The foreigner visiting this place was apt to forget that in other parts of the archipelago the difference between a dry and a wet monsoon is much more striking than at Buitenzorg.

It goes without saying that it is impossible to give in these pages anything like a complete survey of what has been achieved in the field of general botany. It will only be possible to devote a few words to some of the most important things. For other subjects readers interested in these studies are referred to the periodicals mentioned above and to others as well.

It will be necessary to make a classification of the subject-matter (though I am well aware of the fact that any classification must of necessity be artificial) and therefore I intend to discuss first the results of what has been investigated in the field of morphology (including histology, cytology and embryology); after that the physiological researches (including genetics) and last of all to devote a few words to what has been done in the field of what is sometimes called biology in a narrower sense or what is at present also known by the name of ecology; *i.e.* the interaction between plants and their natural surroundings, both as regards inorganic nature and the living beings around them.

Morphological researches were first undertaken by MELCHIOR TREUB. When he was placed at the head of the Government Botanic Gardens, he grasped at once the excellent opportunity to study numerous problems, which could be solved in the tropics only. The many *Loranthaceae* found there led him to minutely investigate the embryology of these plants; the same holds good also for some Cycads and for a few Orchids. But it was of far greater importance that TREUB succeeded in finding the development of the prothallia of some species of Javanese Lycopods. With the help of these he succeeded in constructing a complete developmental history of these Pteridophyta. It should be borne in mind that at that time the result of BRUCHMANN's investigations had not yet been published and that generally speaking nothing was known about the development of the species of *Lycopodium* in Europe and North America.

Of no less importance was his research on the development of the embryosac and the embryo of the *Casuarinas*, some species of which are found in great numbers in the Netherlands East Indies. On this occasion the phenomenon of chalazogamy was discovered which, as NAWASCHIN found at a later date, occurs also among some European plants. Afterwards TREUB investigated the development of the embryosac and the embryo of *Balanophora elongata*. Though ERNST has proved that TREUB was the victim of deceptive circumstances when he assumed that the embryo originated from one of the cells of the endosperm, yet this investigation has yielded a great many valuable data about these strange phanerogamous plant parasites. LOTSY afterwards did state the correctness of TREUB's observations in his study of a few other *Balanophoraceae*.

Numerous other investigators have studied morphological problems though not on such a large scale as TREUB had done. Without attempting to give a complete list, I mention first and foremost GOEBEL, who studied mosses and liverworts, hundreds of which are found in the neighborhood of Tjibodas especially; those who are familiar with those plants need only be reminded of *Treubia insignis*. But GOEBEL did far more. He studied ferns and *Cyperaceae*, *Utricularias*, and *Sonneratias* and his first stay in the Dutch East Indies also resulted in a part of his fine "Pflanzenbiologische Schilderungen." The result of his last visit to Java is embodied in numerous shorter articles but especially in the new edition of his "Organographie der Pflanzen."

Others who might be mentioned are *e.g.* SOLMS LAUBACH, who studied *Rafflesias* and *Psilotum;* G. KARSTEN, for his study of the development of *Gnetum* and also of the very curious *Chroolepideae;* KOORDERS, who investigated the development of the embryo and the embryosac of the teak, *Tectona grandis;* H. WINKLER who investigated apogamy.

Investigations belonging to a more recent period are those by CAMPBELL and ERNST, on ferns and liverworts; SCHOUTE on the ramification of monocotyledons and ferns and the increase in diameter of the stems of some palms; ERNST and BERNARD on the morphology of many Phanerogamous saprophytes; COSTER on the formation of annual layers of wood in the tropics. Many more names might be added to this list, which even then would be far from being complete. Of all these I only wish to make mention of a series of publications by COSTERUS and J. J. SMITH on teratological phenomena in the Dutch East Indies, and the recent work of LAM on flower morphology.

Morphological researches have also been made elsewhere, especially for the purpose of acquiring a profound knowledge of various tropical cultivated plants. An admirable study of the external morphology of sugarcane has been made by

FIGURE 110. — A GROUP OF *Pandanus* SPECIES IN THE GOVT. BOTANICAL GARDENS ~~BUITENZORG~~. *Courtesy Netherlands Information Bureau, New York City.*

JESWIET; its internal structure has been described among others by KOBUS. In various experiment stations a number of investigators have carefully examined the structure of the laticiferous bark of *Hevea brasiliensis;* others have studied the morphology of rice, etc. Here, too, I must confine myself to a few examples and now pass on to the discussion of those investigations that belong to the field of physiology.

Many of these could not possibly have been made elsewhere and we shall also see that many investigations, begun in Java, have led to further and a few orchids, drew the attention of several investigators. The most detailed examination was that of *Dendrobium crumenatum.* COSTER and KUYPER, the last of those who have devoted their time to the examination of this plant, have shown that the buds of this orchid which have reached a definite stage of development come to a standstill until a sudden fall of temperature acts as a stimulus to the full development so that they open nine days after the drop in temperature. In the open air this fall of temperature is usually caused by heavy tropical showers. METZNER

FIGURE 111. — THE VISITORS' LABORATORY ("Treub Laboratorium") IN THE GOVT. BOTANIC GARDENS, BUITENZORG, (built in 1914).

observations in other parts of the world. With respect to these I think of TREUB's investigations about the part played by HCN in plants. TREUB imagined that this HCN was the first product of the assimilation of nitrogen by the plant which ultimately leads to the formation of protein. The great quantities of hydrocyanic acid found in some tropical plants, such as *Pangium* and *Manihot utilissima,* led to these researches.

More closely connected with local conditions in Java were the investigations about phenomena which recur at regular intervals in plants. SCHIMPER's conclusion was that there is an internal periodicity, but this conclusion was based only on chance observations, as he had never made any experiments. KLEBS, however, experimented on a large scale in this field and his conclusion was that the regular sprouting of the buds depends very much on external conditions. It was especially his observations in Java which led him to this opinion. COSTER's investigations on the formation of annual rings may also be said to belong to this category. The curious periodic flowering of some plants, such as Liberia coffee studied the daily periodicity of the movement of leaves of some tropical plants. Root formation was studied by F. W. WENT, BOUILLENNE and WELLENSIEK, and FUNKE made observations on the anatomy of aerial roots. COSTER made an extensive study of root systems of forest trees.

Several economic plants in Java have been investigated as to their physiology; some of these researches gave results of more general importance. F. A. F. C. WENT studied in detail the formation and accumulation of sucrose in sugar cane. Worth mentioning, too, are the investigations about the formation and the function of latex in the bark of *Hevea brasiliensis.* It could hardly have been expected that such a difficult problem would have been solved for good and all, but however this may be, several investigators — among whom ARISZ, BOBILIOFF and FREY-WYSSLING may be mentioned — have found many new facts. Most remarkable are BOBILIOFF's researches in which he succeeded in cultivating the latex cells of *Carica papaya* in an artificial nutrient solution, which enabled him to study them in several respects.

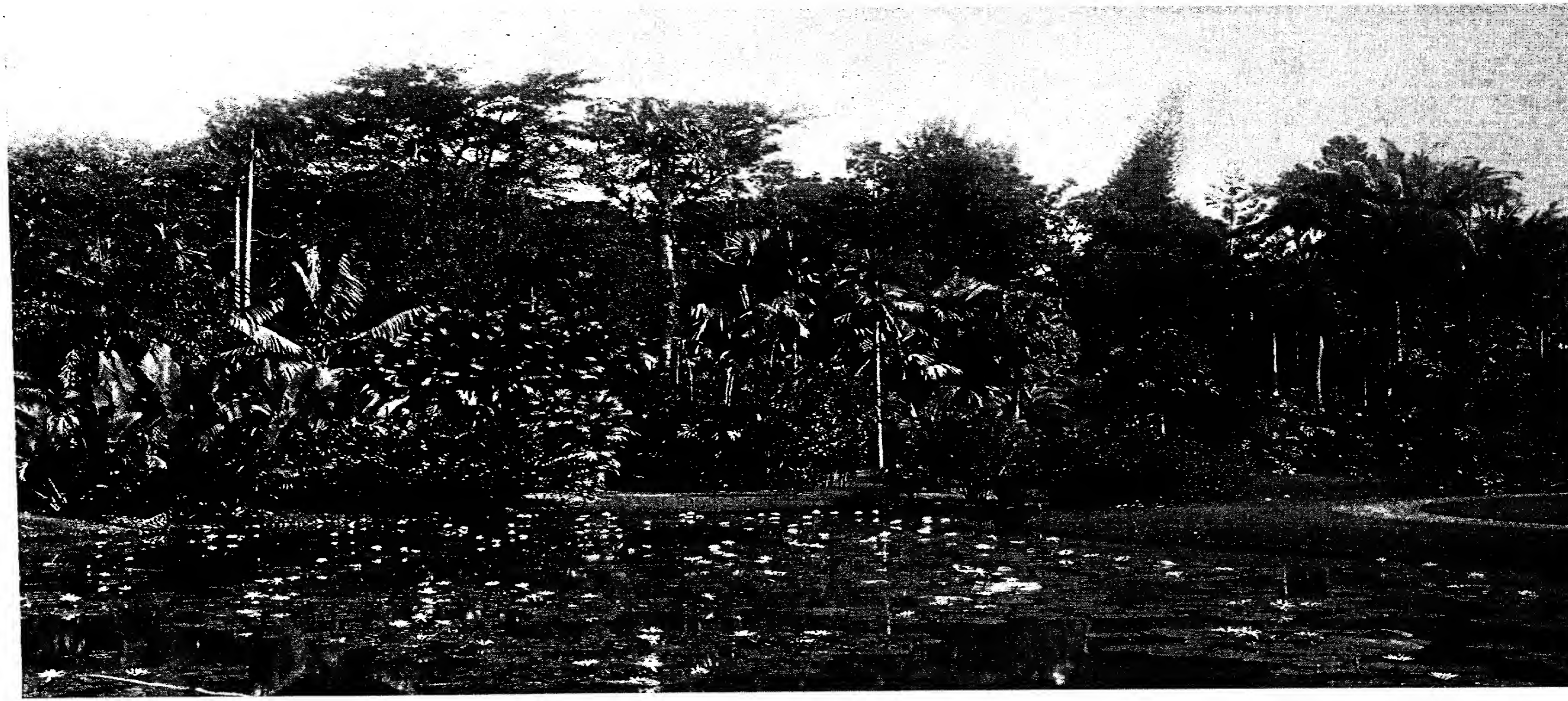

FIGURE 112. — *Nymphaeas* AND PALMS IN THE GOVT. BOTANIC GARDENS, BUITENZORG. — *Courtesy Netherlands Information Bureau, New York City.*

The cultivation of varieties of *Cinchona* led to the studies of the origin and the accumulation of cinchona alkaloids (LOTSY); investigations have also been made on alkaloids in other plants, especially by WEEVERS on the part played by coffein and theobromin in plants.

Experiments on metabolism have been carried out by COSTERUS, GILTAY, STOCKER and VON GUTTENBERG. They also studied evaporation, which had been done also by HABERLANDT and by STAHL. The latter also made a more general study of the function of the leaves with regard to their shape and color. BLUM and RENNER have been studying the suction force of tropical plants, both Phanerogams and Cryptogams. WIESNER, among the many subjects studied by him, devoted his attention especially to the quantity of light which plants in the tropics have at their disposal. Others have studied growth, *e.g.* G. KRAUS, later BLAAUW, J. KUYPER and COSTER.

When G. HABERLANDT is mentioned a second time this is partly also on account of his studies of such hydathodes as consist of living cells; in this case, too, it was Buitenzorg which enabled him to discover this new organ in the vegetable kingdom. But HABERLANDT's work was not limited to these studies. His well-known book "Eine botanische Tropenreise" is almost exclusively a work on Java and more especially on Buitenzorg. It is worth reading by every botanist and gives a brilliant description of the conditions under which plants live in moist tropical regions and of the adaptations found among these plants. Those who have lived in Java during a longer period of time may here and there find something about which they do not agree with the author, but this can hardly be said to diminish the general value of the work. There have been more visitors who have tried to write works of this kind, but none of them have either surpassed or even equalled HABERLANDT. The work that resembles HABERLANDT's most is MASSART's "Un botaniste en Malaisie," while mention must also be made of a Dutch book, of a more or less different aim, *viz.*, to make the educated classes of society familiar with the peculiarities of the flora of Java and Sumatra; I mean BLAAUW's "De tropische natuur in schetsen en kleuren" (Sketches and colors of tropical nature).

A few words must still be said about genetic work. This has been done especially at the experiment stations and hence was undertaken for practical purposes, thus sugar cane, tobacco, cinchona, coffee, tea, rubber, oilpalm, rice, etc., were improved. The results obtained at these stations are often of general scientific importance, such as the selection of *Cinchona* varieties with a high percentage of alkaloids, the selection of *Hevea brasiliensis* and *Elaeis guineensis* and above all the study of sugar cane.

Among those who have studied this subject, JESWIET must be mentioned first and foremost; BREMER deserves to be remembered for the cytology of the various hybrids. Besides, many of the results of the study of sugar cane have thrown light on the vexed question of degeneration, which was said to be a consequence of a continual vegetative propagation of plants. KNIEP has of late made observations at Buitenzorg about the sexuality of the higher fungi.

The discussion of the so-called degeneration has led us to a field which is not pure genetics, but does not entirely belong to physiology either. This brings us to those groups of investigations which refer to the circumstances under which plants live, especially with regard to their surroundings, to the domain sometimes called biology *s.s.* Strictly speaking it is not possible to draw the line between biology and physiology. Hence part of what is discussed here may not improbably be considered by others as belonging to the field of physiology.

The first observations that attract our attention are those about such groups of plants as are most conspicuous in the tropics of Asia, especially epiphytes and mangrove plants. SCHIMPER's best known investigations so far as the epiphytes are concerned were made in tropical America but he continued them in Java and the results are to be found in his "Pflanzengeographie" while others, such as G. KARSTEN and F. W. WENT, have followed in his track. SCHIMPER's great work so far as the mangrove is concerned was done almost entirely in the Dutch East Indies and much of our knowledge is still based upon these observations, though it has become necessary to reexamine a few details, which has been proved especially by VON FABER's observations.

Special forms of climbers and epiphytes were studied by TREUB, among others; mention may be made here of hook climbers and climbing-palms, the curious *Dischidia Rafflesiana* and the *Myrmecodias*. TREUB has proved that the canals in their tubers are not caused by ants, though these animals are always found in them. This subject has been studied more closely by MIEHE and RANT but it is especially DOCTERS VAN LEEUWEN who has of late years brought to light numerous new facts concerning the relation between ants and plants.

We must not omit to mention here that we are also indebted to a former director of the Government Botanic Gardens, W. M. DOCTERS VAN LEEUWEN, for an exhaustive study of all kinds of galls undertaken by him in collaboration with Mrs. J. DOCTERS VAN LEEUWEN-REYNVAAN. This extensive work, begun long before their residence at Buitenzorg, is positively unique for the tropics and a monograph of this kind is something unknown even for many countries in the temperate zones.

Ants and plants in Java have been studied also in another respect. BURCK has studied the extranuptial nectaria. A more detailed and experimental study of this subject was made by Mrs. M. NIEUWENHUIS-VON UEXKÜLL-GÜLDENBANDT, who has proved that even in the country where he made his observations, BECCARI's ideas of myrmecophily are practically untenable when they are made to stand the test of experimental investigation.

Observations on pollination by means of insects, flying bats and other animals have been made by a good many investigators in Java. It would lead me too far to mention the names of all of them in these pages. The only one of these investigators I think incumbent upon me to mention is BURCK, who made a special study of cleistogamy and who in the course of his studies discovered among the *Anonaceae* some plants which produce no other flowers than those that never open. This discovery was the first heavy blow dealt to the ideas prevalent at the time about cross-pollination, which though it would have to take place only occasionally, was at the time assumed to be a necessity for all plants. Also FITTING's observations on the influence of pollen on the flowers of Orchids may be mentioned here,

FIGURE 113. — A TYPICAL *Ficus* ("Waringin") IN THE GOVT. BOTANIC GARDENS, BUITENZORG. — *Courtesy of the Arnold Arboretum of Harvard University.*

though they might be numbered among the physiological investigations.

TREUB's work on the water-containing calyces of *Spathodea campanulata* must also be named here. It was followed by a far more detailed study by KOORDERS, who also devoted his time to other hydathodes of flower buds, especially the calyces of *Clerodendron minahassae*.

In the field of symbiosis JANSE experimented on the mycorrhiza of tropical forest trees. BURGEFF and STEINMANN have of late been studying mycorrhiza fungi in Java, especially those found among orchids. MIEHE and VON FABER occupied themselves with symbiosis with bacteria; these two studied especially the small tumors on the leaves of some *Rubiaceae*, which are caused by bacteria.

A group of plants which years ago already attracted attention in Java are those found on the higher mountains. Long ago they were described by JUNGHUHN, who thought that the same conditions prevailed here as in the Alps, of which an alpine flora was the result. Afterwards SCHIMPER among others laid stress on the xerophytic character of this flora and yet hardly any data of the climate of these mountaintops were available at the time. A monograph of crater plants was published by VON FABER; he supposes that the soil plays an important part here and it is his opinion that there is no question about an adaptation to an alpine climate. Both DOCTERS VAN LEEUWEN and VAN STEENIS published extensively on the mountain flora.

Are we to mention the investigations by CLAUTRIAU and others on insectivorous pitcher plants under this head or do they belong to the field of physiology? This much is certain, that these investigations gave impetus to the study of a group of plants a great many species of which are found in the Dutch East Indies and of whose conditions of life very little is known. The same might for that matter be said in a good many cases; every botanist who reaches Java or rather who sees the Dutch East Indies is struck by the great number of problems to be investigated yet.

One of these problems deserves to be mentioned in these pages though I am well aware of the fact that it might be said to belong to the field of geographical botany rather than to the subject in hand. I mean the appearance of a new flora on the island of Krakatau after it had entirely lost its vegetation in consequence of the well known eruption of 1883.

TREUB was the first to call attention to this problem and visited the island several times. Others have followed his example and it was especially DOCTERS VAN LEEUWEN who devoted his time to observations of this kind. It will hardly be necessary to say that it is of great importance to find out by means of an experiment on a large scale, like the one made by nature itself in this island, what are the first plants that can develop in a virgin soil and in the second place how these are gradually ousted by others.

Two very interesting monographs, by DOCTERS VAN LEEUWEN and by ERNST, were published ten years ago on Krakatau. The destructive criticism of BACKER of all research work concerning re-establishment of a flora on Krakatau can in no way lessen the value of the work done.

The spectacle of the struggle for life is enacted before our eyes in this island so that we need not theorize about it. It is sometimes maintained that in a tropical jungle the struggle for life is something terrible, but here, too, it was TREUB, who called attention to the fact that in most of these forests an equilibrium is found in consequence of which a struggle for life as the term is generally understood is hardly noticeable.

A work like the present can only give a very general survey of what has been achieved in the field of general botany in the Netherlands East Indies, both by Dutchmen and by foreigners. In spite of this the reader's impression will not unlikely be that a great deal of work has been done in the archipelago. For all that, investigators will find that the number of problems to be solved is legion.

It would seem to the present writer that there is no better place than the Netherlands East Indies to study a great many general tropical plant problems, not only because no more luxuriant vegetation is to be found anywhere else in the world, but especially because the laboratories for scientific research in these islands are better equipped than anywhere else in the tropics. Research can be carried on at the several experiment stations or in the Government Botanic Gardens. I should like to mention once again the Treub Laboratory and more especially the laboratory at Tjibodas, this splendid foundation of MELCHIOR TREUB, which perhaps would better bear the founder's name than the institute at Buitenzorg because it will be impossible to find a more suitable place for research work than Tjibodas, where experiments can be made not only in the vicinity of the jungle but even in the forest itself and under circumstances closely resembling those under which plants live in the open air.

It is hoped that after the war the Botanical Institutions in the Netherlands East Indies will resume their temporarily interrupted development and will continue to be among the first to further botanical knowledge of the tropics. Nowhere can one get a better initiation in tropical problems, and re-establishment of endowed or Government supported fellowships to study tropical life in the Netherlands East Indies should be strongly recommended.

# The Tjibodas Biological Station and Forest Reserve

## I, A NATURALIST'S PARADISE

*by*

F. W. WENT, Ph.D.*

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The reason for including the following three articles about such a special location as Tjibodas may seem far-fetched to the un-initiated, but not to those persons who have had the privilege of working in the laboratory and rain forest at Tjibodas. Situated in a vast park, with magnificent vistas across luscious green lawns, bordered by forest and groups of conifers, the laboratory and pasang-grahan (government guest house) offer the visiting biologist adequate working and living quarters. Behind the laboratory, one of the best protected, best known, and richest mountain rain forests of the tropics reaches from 4500 to 10,000 feet up the slopes of the twin volcanoes, Gedeh-Pangerango. I have seen botanists, bryologists, mycologists, entomologists, ornithologists, and lichenologists grow enthusiastic when they discovered the riches of the flora and fauna of the forest behind Tjibodas, and even a marine biologist contentedly settled down to investigating fresh-water crabs.

The following articles describe what a botanist, zoologist, and horticulturist will find in Tjibodas. But these articles are of more than local importance: whereas the richness of tropical life makes a general review difficult, these short descriptions give a remarkably good insight into the life of the flora and fauna of a limited region, and are a good introduction to the tropics.

After having spent a probable total of twelve months in Tjibodas during the years 1928–1932 and being in a position to compare it with many other spots in the world, I have come to the conclusion that, if Paradise still exists on earth, Tjibodas, before the Japanese invasion, must have been part of it. If someone wanted to object to this by arguing that the most ruthless struggle for existence can be found in a tropical jungle, making it the antithesis of Paradise, I could answer that, to my surprise, I found much less of such struggle than I had expected, and that, if only survival of the fittest existed, the flora and fauna would be much poorer. It seems rather that birth control and mutual dependence determine which plants live where.

A biologist's first impression of a tropical rain forest is bewilderment; the forest seems complete chaos. It takes a rather long and intimate association with a particular forest before the biologist starts to see some order in the arrangement of trees, shrubs, herbs, and epiphytes; then more general laws begin to emerge. In the case of epiphytes, I found, for instance, that a very marked and strict relationship between light and host tree on the one hand and species of epiphytes on the other hand exists. Certain orchids are found only on certain trees; this is so marked that host trees can often be identified by the specific community of epiphytes living on their trunk and branches (WENT, F. W., "Soziologie der Epiphyten eines tropischen Urwaldes." Ann. Jard. Bot. Buitenzorg 50:1–98, 1940, abstract in Biol. Abstr. 15 (2):188, no. 1923 (1941)). Tjibodas is an ideal place for ecological studies; much has been done there, but much more remains to be done.

* Dr. F. W. WENT, who spent much time in research in the Tjibodas Biological Station, kindly prepared this introduction to the following three accounts of various aspects of life in and near a tropical rain forest. — Most of the foreign visitors who worked at the Tjibodas Station will be found in DAMMERMAN's historical account on pp. 59–75.

# The Tjibodas Biological Station and Forest Reserve

## II, THE FAUNA OF TJIBODAS

*by*

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No sooner have we arrived at Tjibodas than our ears are greeted by a remarkable cry of "sat-cu-cu" (or the last two syllables only, short and quick). It is the note of the East Indies cuckoo (*Cuculus poliocephalus*), which closely resembles its European relative but is smaller and not easily seen, although its characteristic call re-echoes all day long high up in the distant trees.

We hear also all around the curious note of another species of cuckoo, the rufous-bellied cuckoo (*Cuculus merulinus*), which, besides the call to which it owes its Dutch name "Piet van Vliet" (pron. pete-fun-fleet), also utters a rather monotonous "pete-pete-pete," the repetitions increasing in pitch and frequency. It is an inconspicuous bird, too, and seldom seen; seated motionless upon a branch its greyish brown plumage renders it almost invisible. When we think we have located it by its call, the bird has long since seen the intruder and silently flown off to repeat its note some distance away.

But there are a number of other birds in the park whose acquaintance is more easily made. We mention here the birds in the first place, because there are so few other creatures that reveal their presence, and to see them one has to go in search of them. The bright azure-blue of wings and tail of the white-collared kingfisher (*Halcyon chloris*) strikes the eye as it drops upon an insect from a bare branch, to return to its perch with a harsh "kak-kak." The same habit is exhibited by the drongos, the smaller grey species of which (*Buchanga cinerea*) is most often seen here. This bird, too, loves to take up its position on a bare branch or other projection, from which it swoops down upon its prey in an extremely neat and well-executed volplane. It is readily recognized by its long forked tail, to which it owes its Malay name "salagunting" (false scissors).

Among other denizens of the park are two species of starlings, which immediately advertise their presence by their loud screams. We notice the familiar "jalak," the pied mynah (*Sturnopastor jalla*), with a naked orange coloured patch on the side of the head, and the more sober crested mynah (*Acridotheres javanica*), with its yellow beak, which is more conspicuous on the wing on account of the white band on the primaries and tail. There is also a shrike with fine colouring: brownish red above, which sets off to advantage the grey of the upper part of the head and the neck; wings and tail blackish with white markings. This is the common Malay shrike (*Lanius bentet*) and one can hardly imagine that this lovely bird is the butcher it actually is. On the sharp points of the leaves of the agave to be found in the park are not seldom to be seen evidences of its real nature: a bumblebee or a locust cruelly impaled, or sometimes even frogs or lizards — a feast deferred for moments of greater leisure or better appetite.

Turning our attention for a moment to the peculiarly shaped grass-trees in front of the house, it is noticed that these odd rather than beautiful mops balanced on their stout stems afford a suitable nesting-place for numerous munias (*Munia leucogastroides*), tiny birds with dark-brown coat and white belly. We hear also a familiar note that recalls at once the bulbul of the plains; it is uttered by a near relative (*Pycnonotus bimaculatus*), which may be identified by the orange patches at the base of the upper half of the bill. The true yellow-vented bulbul (*Pycnonotus aurigaster*) is also found here but it is far from common, being really a lowland species. Indeed, all the birds named above, except the East Indies cuckoo and the mountain bulbul, are not typical species of this comparatively high elevation (1400 metres) but are at least equally plentiful in the lowlands.

If we want to see more of the animal life in the mountains, we must enter the original jungle that commences directly at the back of the buildings of Tjibodas, primeval forest untouched within human memory at least. We shall certainly see a troup of monkeys, either gibbons or leaf monkeys. The crested leaf monkey (*Pithecus mitratus*) is the more common and one will seldom look in vain for it in this forest. When we stand in our tracks, they watch curiously to see which way we are going, the black crests erect and light coloured bellies showing, while the long tails hang straight downward. The gibbons (*Hylobates leuciscus*) are of a more uniform grey colour, with the exception of the upper part of the head which is black; they are further distinguishable immediately by the absence of tails; the species is the only one known in Java where, too, it is confined to the West.

The common kera or macaque is seldom or never seen at this elevation. The ordinary black monkey or lotong (*Pithecus maurus*), so common in the lowlands, is found here also.

Other mammals one seldom sees, except sometimes a small tree-shrew (*Tupaia javanica*) searching the bushes for insects, while one might certainly consider oneself very lucky to espy the *Hylomys suillus*, a member of the hedgehog family. This is a quaint creature, no bigger than a small rat with a typical short tail.

The bird-life is on the whole easier to notice, at any rate if one has a pair of field-glasses, but even then one can sometimes wander on without hearing any sound to betray the presence of the birds. When approaching a little stream, however, we are fairly certain to hear the shrill cry of a fork-tail (*Henicurus leschenaulti*) and we

* Reprinted from "Tjibodas (Zoology)," Fourth Pacific Science Congress Guide Books (Java 1929), Excursion C. 3, pp. 3-21 (1929).

Figure 114. — The dormitory (*right*) and curator's residence (*left*) in the Mountain Gardens of the Govt. Botanic Gardens at Tjibodas, near Sindanglaija, West Java. — *Courtesy Arnold Arboretum of Harvard University.*

may have the luck to surprise it, but usually it vanishes at our approach and all that is seen is its black and white plumage as it runs ahead along the path or darts into the dense undergrowth at the water's edge or disappears round a bend. The bird that most attracts our attention is the mountain scimitar babbler (*Pomatorhinus montanus*). No other bird has such a striking and varied repertoire as this reddish brown member of the Timeliid family that may be distinguished by a white streak above the eye, which shows off against the dark colouring of its head. At first the impression is gained that it is several different birds we hear, until we discover that it is the same brawler every time. They have a peculiar partiality for duets: one sings "booah-booah" and the other chimes in with "kopi-kopi," the result being "booah-kopi, booah-kopi." Besides its "kopi-kopi," which has earned it its Malay name of "burong kopi" (coffee bird), it utters also a clucking "jock-jock — jock-jock" or a hoarse scream or, again, a loud blustering cackle. There is another bird that is frequently heard, namely the *Laniellus leucogrammicus;* its call is a quickly repeated "cheeü-cheeü-cheeü" that recalls the shrill chirping of a large long-horned locust. This shrike is brown above with white longitudinal stripes and dark head; the underside is white.

The hammerings and calls of the barbets always strike the ear. There are several species here at Tjibodas but the least common is the well-known coppersmith of the lowlands (*Xantholaema rosea*), which repeats its monotonous and never ending "ankut-ankut-ankut" from its hidden retreat in the treetops. Much more commonly heard are two other species, though these are not so often visible. One has a call which forcibly reminds us of the Chinese pedlar's clapper and which entitles it to the sobriquet of "burong klontong" (pedlar bird). Its peculiar vibrant call is heard all day long; it is a smaller species (*Cyanops armillaris*), green with blue top to the head. A larger barbet (*Chotorhea corvina*) makes a knocking sound preceded by a vibrating quaver.

While there are times when every sound is stilled, there are other moments when the air is vocal with the hue and cry of birds and one has scarcely time to note all the members of a passing flock. One of the most striking on account of its rich colouring and its loud parrot-like cry of "kaka-twee-kaka-twee," is the *Cissa thalassina*, a thing of beauty in its light blue-green plumage with reddish brown of wing feathers visible in flight.

We see several racket-tailed drongos (*Bhringa remifer*), shining black with a green gloss, with spatulate tail-feathers gaily waving behind them as they fly. The young bird lacks this ornament. One recognizes a family trait of the drongos in their chatter and busy flights to and fro. The company may also include a number of fan-tails (*Rhipidura phoenicura*); their coquettish movements and spreading of their fine reddish brown tails betray their relationship to the "burong kipas" (*Rhipidura javanica*) so common in the plains. Their rather hoarse cry is scarcely in keeping with their pomp and parade.

When our attention is not distracted by the birds in the trees, we can spare a glance for the dark shady path. A butterfly flits ahead with wings plain brown above; as it alights it vanishes from sight, so little do the closed wings, dark brown with a few rows of tiny eye-spots, stand out against the colour of the soil. This is the *Precis ida*, a Nymphalid. Low over the path steers a large bumble-bee with a thick black fleece (*Bombus rufipes*), the only true bumble-bee that Java can boast of; it is commonly found from this elevation up to the summit of the Pangrango. Its nest is made in the earth and the big heavy females are easily distinguishable from the smaller males and the still smaller workers.

Later in the morning as the clamour of the birds quietly subsides, we can pay better attention to other things. We retrace our steps to the park to see what interests the fresh-water ponds can provide. The large pond is very poor in animal life, but the smaller ones in front of the new laboratory, thickly-grown with water plants, support a number of interesting specimens. Very abundant is a fresh-water snail (*Limnaea javanica*) while various species of whirligigs spin giddily over the water, the most noticeable being a very large one (*Dineutes politus*). We find here also a large red crab over 5 cm. wide (*Potamon brevimarginatus*); these creatures are nearly always covered with curious primitive worms (*Temnocephala semperi*) which belong to an aberrant Trematod genus found also on the well-known crabs of the rice fields. They are small, white, and flat, only about half a centimetre long, conspicuous on account of the five tentacles at the fore-end, while the rear contains a sucker with which the worm adheres to its host. The latter is not inconvenienced in any way, as it is used only as a vehicle of transport in the guest's search for food which consists of tiny water-creatures.

We see also a number of tadpoles, among them those of the tree-frogs *Rhacophorus reinwardti* and *R. leucomystax;* the latter are distinguished by a white spot on the snout which glitters like silver in the water. This spot gets more and more pigmented as the tadpole grows. Unlike most frogs, these tree-frogs do not lay their eggs in the water but deposit them in a great lump — sometimes as large as one's fist — on the leaves of trees growing by the water-side. The newly-hatched tadpoles drop either directly into the water or on the edge to be washed in by the rain.

Other remarkable tadpoles are to be found in the quickly flowing streams in the forest. In quieter water we must look out for the larvae of the *Megalophrys montana*. This tadpole which can grow to 6 cm. is remarkable for the strange funnel-shaped apparatus it carries round its mouth. It can be often seen with this funnel stretched open and hanging from the surface of the water; it appears that in this way it appropriates all sorts of small algae and plant particles that float on the water. The adult frogs are typical mountain-dwellers; they are conspicuous for the triangular protuberances on their heads above the eyes.

A stroll in the evening twilight or dusk is frequently as profitable as an early morning one. As soon as twilight falls the cicades set up their concerted screaming, which is timed to open and close at the same hour every day. But it is extremely difficult to spot them not only in the semi-dark but even in full daylight. As we try to locate one by its noise, the screaming stops at once and before we realize it the insect has flown away. A very common cicada at this elevation is *Platypleura nobilis*, about 3 cm. in length, the

large translucent wings included, which are adorned with brown markings, especially so on the fore-part.

If we have no objection to traversing the forest in the dark, we shall be amazed at the large number of mosquitos, more so as in the bungalow one can sleep without a mosquito-net. Protected by a strongly scented oil smeared on face and hands, one can walk on undisturbed. The chances of meeting with larger beasts of prey are extremely small, although panthers are found here and have even been seen in the neighbourhood of Tjibodas. In fact, an attempt was once made to establish a deer enclosure in the park but the animals were carried off one by one by panthers. The natives even assert that tigers have not altogether disappeared from these regions.

However, we can none the less safely walk in the forest at night as the only beast of prey likely to be met with is the skunk (*Mydaus javanensis*), a creature about the size of a small dachshund. It has a very short tail and is of a dark brown colour with a white stripe running along the head and back. Small as it is we had better keep out of its way for when disturbed it ejects from certain anal glands a horribly foul-smelling liquid, which is nauseating enough to make a person sick, while it is even said that sensitive people have fainted from this dreadful stench. Fortunately we seldom meet the creature, although it is quite common near Tjibodas and even on the summit of the Pangrango, as along the roadsides and the base of the trees we may find traces of its nightly digging with its long claws for insects and worms.

Another mammal belonging to this zone is the flying squirrel (*Pteromys nitidus*) with its beautiful chestnut coloured fur, which is stretched membrane-like between fore and hind-feet and enables the animal to make fairly long gliding flights from tree to tree. In the twilight it emerges from its hiding-place high up in the trees and it is generally in the half-dark that it begins its search for food. Another remarkable denizen of the forest, which also does not make its appearance until dusk, is the strange flying lemur (*Galeopterus variegatus*), which, however, is not limited to this region, but it is found from the seacoast to very high up in the mountains. It is related to the Insectivora but differs from them in several respects and can plane through the air by means of a skin membrane between fore and hind-feet and tail.

The forest at night is full of all sorts of noises; the dead silence one might perhaps expect is simply an illusion. Although the bird choir is stilled there are other creatures which choose the night to give expression to their "joie de vivre" as the birds choose the day. But in the darkness of night it is infinitely more difficult to find out from which animals the various sounds emanate. Crickets and locusts take the leading part in the nocturnal concert with their shrill stridulation and penetrating chirp; frogs join in, and some species really do pipe rather than croak. There is another shrill whistling that we may hear in the darkness and we shall be surprised to learn that it comes from a peculiar lizard-like creature, *Gonyocephalus*, which is distinguished by a flat dent between the eyes and a tall crest on the neck.

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A longer sojourn at Tjibodas will perhaps include a trip to the Tjibeureum waterfalls. The road at first descends from the park through a narrow strip of forest that has been left intact on its boundary. On the path is noticed the yellowish brown butterfly (*Precis ida*) so common in the forest. Another species flits about, plain dark brown above with the forewings ornamented with a strikingly bright blue transverse band (*Amnosia decora*). In the valley formed by the little Tjiwalen stream, which we cross, we can see the gorgeous *Papilio arjuna* (*gedeensis*) usually drinking in moist places; it is of a bronzed green colour, the tailed hindwings adorned with a large light blue patch and a purple ocular spot. Here is also seen an old European friend, the thistle-butterfly (*Vanessa cardui*), which has spread over almost the whole world, South America and the Poles excepted, and is not rare in Java above an altitude of 1000 metres.

Having crossed the valley the road ascends again and continues almost all the time through dense forest. Here again it is the birds that mostly attract our attention. We hear the clapper of the pedlar bird, the mocking "hee-hee-hee-hee" of the laughing-thrush (*Garrulax rufifrons*), that recalls the neighing of a horse and has earned for it its Malay name of "burong kuda." Our progress is accompanied by the singing of *Brachypteryx montana*, a small bird, the male being bluish black, the female more a greyish brown. It greets us with a short but pleasant song; sometimes it seems to sing right into one's ear but, peer as one may, one fails to discover the little songster, securely hidden in the low dense shrub. Then there rings out the call of the hill-partridge, *Arboricola javanica*, beginning with a dull "tong-tong-tong" rising higher and quicker until the climax is reached in a loud clear "tü-tü-tü," often repeated. This dark brown partridge with black markings on its head is not easy to see; an odd one may swiftly cross the path or a small couple may be surprised on an open bit of ground. Again, a flock of minivets (*Pericrocotus*), of which three species occur here, may catch the eye. The dark green of the trees will then be enlivened by the brilliant vermilion-red and black of these little birds, as they flit merrily from tree to tree in small companies. We will also probably meet a pair of trogons (*Hapalarpactes reinwardti*) betrayed by their shrill "pseerr-pseerr." They have the most variegated plumage of any of the bird denizens of the Malay forests; beak and feet are red, upper part of the body mostly greenish, wings striped with yellow, skin round the eye blue, and the under part of the body orange-yellow while the breast is more brown.

Now and again there comes a lull and we see and hear little of bird-life, until we come suddenly upon a loud and busy company loafing among trees and shrubs. We notice once more bhringas, babblers and shrikes, while a small nuthatch (*Callisitta azurea*) draws the eye on account of its striking dark blue colour with light blue patches on the wings and a white breast.

Mammals are rarely seen, at most a couple of squirrels which quickly dodge round the trunks of the trees; or perhaps a troop of leaf monkeys which drop into the ravine with an amazing series of leaps, most of them are not seen, though their presence is revealed by the heavy flop of their falling bodies and the rustle of the branches.

We are sometimes struck by the shrill cry of the ground squirrel (*Lariscus insignis*), which has three black stripes down the back and a comparatively short tail. This animal, too, is not easily seen, for it lurks mostly on the ground amid the undergrowth.

On the path, if it is rainy weather, we may expect to come across some terrestrial planarias, black flat worms with a two-lobed fore-end, some species of which, f.i. *Bipalium marginatum*, can reach 15 cm. in length. They feed on earthworms and one sometimes finds the victims wrapped about by a planaria. And in the dry season one sometimes sees a strange sight, namely the appearance across the path of a long narrow column comprised of thousands of worms of a striking orange colour, making a slow onward progression. These are so-called "processional maggots," the larvae of a blackish fly (*Sciara*), which live on half decayed leaf matter in which the forest here is very rich. Their method of progression is very remarkable: — the undermost creatures lie quite still, while those above propel themselves, more and more rapidly according to their position near the top, over the living causeway until they touch the ground in front and become in their turn the immobile supporters of their successors in the movement. The reason for this strange mode of progression remains to be ascertained.

After an hour's walking we come to an open place about 1600 metres above sea-level, where the path to Tjibeureum turns to the right. Taking this path for about five minutes we find on the left a narrow climbing track and following it we come in a few minutes to a cave, which is a mere hollow in the volcanic rock holding water. It is the home of numerous bats which fly about wildly in its recesses when disturbed, and the movement of their wings in the hollow cave sounds like the rumble of distant thunder. In other respects the cave is extremely poor in animal life; at the entrance we see water-bugs and large whirligigs (*Dineutes politus*) gyrating on the water. In the water itself a bryozoan (*Plumatella diffusa*) has been found on submerged branches. The members of a true cave fauna are completely absent.

Returning to our original path we soon reach the waterfalls and we may watch the skimming flights of numerous swifts (*Collocalia linchi*) along the beautiful falling or running water. These are related to the species that build the well-known edible nests but are distinguished by the lighter hue of the under part of their bodies. On the rocks at the foot of the falls one finds the *Crioteltix saginatus*, a small grasshopper with sharp lateral spines on the thorax, which leads a semi-aquatic life.

In the damp forest round about are many of those curious frogs belonging to the genus *Megalophrys*, the tadpoles of which have been mentioned previously. Common also are the whistling-thrushes (*Myiophoneus*) which dart ahead of us flying low and uttering a high-pitched whistle. This region has attracted a very great deal of interest among biologists owing to the wonderful pitcher plants (*Nepenthes gymnamphora*) found here in abundance. We have only to penetrate the forest to be sure of coming across these plants. At first one sees large numbers of pitchers on the ground and partly embedded in the soil. With such indications we can easily follow the plant as it climbs the trees and detect the pitchers suspended in the air. These pitchers have deservedly attracted the attention of both botanists and zoologists, because they serve as insect traps and digest the small creatures that fall into them. HABERLANDT styles this as a luxury device (Luxusanpassung) because he considers that over against a very complicated equipment stands a proportionately meagre advantage gained thereby. That view, however, is not entirely supported, when one notices the large quantities of insects and other small creatures caught in them, especially in the ground pitchers. The pitchers also contain animals which not only can withstand the albumen-dissolving secretion from their walls but even thrive in this vegetable digestive juice. Larvae of gnats and flies, mites and small eelworms live in it, among the latter even a true parasite (*Anguillula nepenthicola*), which goes through its whole life-history in the pitchers, but it is only found in the suspended ones.

Back from our trip we shall probably notice that a few leeches have been picked up on the way and, if they have not already dropped off, we shall find the blood-gorged creatures still adhering to our legs. These leeches (*Haemadipsa zeylanica*) live in the forest and not in the water as most leeches do. They lie in wait on the paths or in the undergrowth constantly groping about for their human or animal victims. JUNGHUHN even styles the region between 1000 and 1800 metres the zone of the land leeches.

In order to make acquaintance with the higher mountain zones we must take the road to Kandangbadak. We first follow the road to Tjibeureum until we come to the point where the path to the waterfalls diverges. The road then makes a somewhat steeper ascent through the sunlit moss-clothed forest consisting mostly of smaller trees, above which towers alone the giant, straight-limbed *Podocarpus*, the needle-like foliage of which stands out in a finely drawn silhouette against the bright sky.

Little animal life is noticed, though leaf-monkeys are regularly met with and usually there is heard here and there the song of *Brachypteryx*. This is probably the bird that JUNGHUHN praises as one of the best songsters of Java's higher regions, although he gives it the name *Muscicapa cantatrix*, but the latter species (otherwise *Cyornis banyumas*) is not found at so high an altitude.

Above our heads a green barbet gorges a cluster of berries. Further on a small bird (*Muscicapula hyperythra*) sits quietly on a branch overhanging the edge of the path, allowing us an unimpeded view of its coat which is bluish black above and lighter beneath with red throat and breast.

At an elevation of 2150 metres we pass some hot springs, the presence of which is revealed from far away by the spreading vapour. The water, which has a temperature of about 50° C., pours down over a thick growth of bluish green algae. No animal life appears to have been found in it yet.

After a four hours' climb from Tjibodas we reach the shanty near Kandangbadak 2400 metres up and built on the saddle between Gedeh and Pangrango. Seated peacefully before the house in the quiet afternoon, watching the mist stealing over the path in front of us and over the trees, festooned with streamers of white lichens, we could think ourselves back in the times when

rhinoceroses (Malay "badak") roamed here as in JUNGHUHN's days, whence the name given to this spot. JUNGHUHN, who was the first European to climb the Pangrango (in 1839), on arrival on the top surprised two specimens there, one submerged in the brook and the other grazing on the bank. When we read further in this eminent naturalist's description of Java's mountains and flora that in his time unexplored mountain summits were generally climbed along the rhinoceros tracks, frequently blocked by an accumulation of their droppings, we can only regret that in Java this remarkable pachyderm is almost extinct.

The larger mammals have almost entirely disappeared at this high elevation and it is only the calls of birds that reach our ears. From the neighbouring forest one hears a strange lament, like a long drawn out "oo-oo." It is the coo of *Ptilinopus roseicollis*, a very fine green fruit pigeon embellished by a light purple head, neck and breast; its coo alternates with the loud laugh of the laughing-thrush. Braving mist and rain is a wandering flock of shrikes (*Laniellus*) with their ceaseless "cheeü-cheeü," while little white-eyes (*Zosterops fallax*) silently work over the shrubs. We may usually see some fantails, coquettishly hopping from branch to branch and every now and then spreading and lifting their beautiful reddish brown tails.

*Brachypteryx*, our well-known songster, is one of the last to be heard in the evening and also the first in the early morning as it greets the sun breaking through the cloud bank of the distant horizon. Soon the whole choir joins and proclaims its joy in the dawn, though *Brachypteryx* with its clear melodious notes, triumphs over them all.

In fine sunny weather we start our journey to the crater of Gedeh. The air is much stiller here than lower down around Tjibodas; only the cuckoo-doves (*Macropygia leptogrammica*) betray their presence by their noisy flapping as they leave the trees. This is a typical denizen of the mountains. Descending to the stony crater field, where the vegetation grows thinner and thinner, we espy now and then, as they fly past, the lovely dark brown mountain thrushes (*Turdus fumidus*) with their yellow beak and feet. This thrush's habitat is limited to the highest mountain tops.

Seated on the edge of the crater of this extinct but still imposing volcano, one may often see a bird of prey circling over this forsaken ground. The clefts and hollows of the bare rocky walls are the homes also of a distinct species of swift (*Collocalia vulcanorum*), distinguished by its thick-set build and, as far as is at present known, found only here in the Gedeh crater.

The mountain thrushes just mentioned are also very common on the top of the still higher Pangrango mountain (3000 metres) and may well claim to be the most common bird there. There are not very many birds at this great height, only 15 species being observed. After the thrushes the white-eyes (*Zosterops fallax*) are the most plentiful. The Latin name indicates the absence of the ring of white feathers round the eye, which is characteristic of the rest of the genus *Zosterops*. In the early morning hours their soft fine notes are heard all round the summit, sounding like a long drawn out "pee-er-vee-er."

Mammals are still scarcer and larger wild animals almost entirely absent, although one may notice the occasional prints of a deer or pig and even the panther pursues its prey up to this height. Gone are the rhinoceroses formerly not rare beasts here. The only mammals still common are rats (*Mus lepturus*) and the skunk. Insects are the most abundant and flies, especially the hover-flies, take first place, while the Javanese bumble-bee also is among the everyday visitors to the mountain flowers. Among the insects are a number of forms, commonly found in more temperate regions or related to palaearctic species, an interesting fact which is true also of some plants growing on the highest mountain summits.

# The Tjibodas Biological Station and Forest Reserve

## III, THE FLORA OF TJIBODAS

*by*

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The mountain garden partly owes its existence to the introduction of the cinchona culture in Java. The garden, to be sure, had been there before, but in 1852 TEYSMANN, the well-known Curator of the Botanic Gardens, planted here the first cinchona trees. The same Curator also laid out small experimental gardens on the mountain slope, *viz.*, at Tjibeureum at a height of ± 1700 m., at Kandang Badak at 2400 m. and on the summit of the Pangerango at 3000 m. above sea-level. In the year 1856 JUNGHUHN was charged with the direction of the cinchona culture. He considered the soil at Tjibodas unfit for this culture, and the cinchona estate was continued in the surroundings of Bandoeng near Lembang. Thus the garden at Tjibodas was once more annexed to the Botanic Gardens. If during the first years of its existence this garden was meant chiefly for the culture of sub-tropical plants, after TREUB's arrival in 1880 a beginning was made with the study of the virgin forest in which, besides TREUB and other Dutch scientists, a great many foreigners took part as well. A guest-house with laboratory was opened in 1891 while the virgin wood was added to the garden as a nature reserve up to beyond the Tjibeureum waterfalls

* Reprinted from "Tjibodas (Botany)," Fourth Pacific Science Congress Guide Books (Java 1929), Excursion C 3, pp. 3-17 (1929).

In 1920 a new laboratory was opened, built from funds presented at the centenary of the Botanic Gardens by Dutch and foreign scientists. Moreover in 1926 the virgin forest covering a field from Tjibodas to the summits of the two volcanoes the Gedeh and the Pangerango was declared to be a nature reserve and this field measuring some 1200 hectares was adjoined to the garden proper — which covers 60 hectares — for the purpose of research-work. In this forest no felling is allowed except what is necessary for the upkeep of the forest-paths leading to all directions.

Tjibodas can be reached from Buitenzorg by two ways. One is by train to Tjiandjoer, from there by car to Tjipanas, where the Governor-General has a country-residence. A foot-path leads from Tjipanas to Tjibodas. But one can also drive straight to Tjipanas by car across the Poentjak-pass. This way leads through arable land and native villages, through tea-gardens, and rises to 1400 m., where the height of the pass is reached. The way, hollow here and there, goes close to the highest point through remnants of virgin forests, which formerly covered all the slopes. From the highest point the way goes down to Sindanglaja, and leads further to Tjipanas. Tjibodas can also be reached from Sindanglaja by a foot-path.

Up to the border of the nature reserve everything is deforested; native arable land on which potatoes and cabbage are grown is found there. A wooden bridge spans the river Tjibodas, which forms the western border, and from this point a path leads to the park proper, the garden. To the right a sloping lawn begins with a small pond, and from here the road goes up, under old *Araucaria* trees, as far as the guest-house. The house of the assistant-curator lies to the lefthand side of this building, and a little beyond the new laboratory is situated. In front of the guest-house are the lawns planted with all kinds of trees and shrubs, behind the new laboratory the new green-houses are situated, and this whole field borders on the virgin forest, which extends from this point up to the summits of the two volcanoes the Gedeh and the Pangerango.

JUNGHUHN divided the vegetation of Java in various zones and distinguished the hot zone of the sea-coast up to some 650 m., the second or temperate zone from 650 to 1500 m., the third or cool zone from 1500 to 2500 m., and the cold zone from 2500 m. upwards to the summits of the mountain-range. The vegetation of Tjibodas lies in the two latter zones, consequently in the cool and the cold zones of JUNGHUHN. The Gedeh rises up to 2981 m. and the Pangerango up to 3060 m. above sea-level. The vegetation of these two zones gradually merge into each other.

The short time which the members of the Congress can spend in Tjibodas does not allow a view of the flora as far as the summits of the volcanoes. However, an excursion to the Tjibeureum waterfalls will be possible. Accordingly this excursion leads through the nether part of the second zone of JUNGHUHN, but nevertheless some plants will be found occurring much lower, on account of special circumstances, than is usually the case.

The rainfall in these forests is very abundant, likewise the number of raindays; moreover, the dry monsoon is restricted to a few months only and very often this season lasts no more than a few weeks. We are consequently in the rain-forest, and the way to Tjibeureum leads entirely through such a wood. Characteristic thereof are the great number of species of trees and the abundance of epiphytes in their tops. Some trees become very tall, amongst others the rasamala (*Altingia excelsa* NOR.), which in Java occurs only in the western part and rises high above most other species of trees. Specimens of 60 m. or more are by no means rare. The tree tops do not, however, form a canopy, besides, the storms blowing regularly during the months of February and March fell a lot of trees and snatch off many branches. For this reason the wood cannot be called dark, and consequently a good deal of light can reach the soil. The consequence thereof is that the undergrowth of the forest is very exuberant. Shrubs and herbs cover the soil with a luxuriant vegetation, and among the latter are many hygrophytes. Ferns occur in large numbers, which on but few mountains reach such a stage of development. Many lianes reach to the tree tops and impart a peculiar aspect to the wood at certain places. Moreover, the field is particularly rich in brooklets and marshy spots, and in these very spots the vegetation of aquatic plants is most luxuriant. At some spots, the brooks and rivers have washed away deep grooves in the landscape, and the mountain ridges situated in between consequently retain comparatively little water, and the vegetation is less luxuriant on these ridges than in the humid part of the forest. The trees are generally smaller and the undergrowth less dense. In this lowest part of the wood of Tjibodas, the development of mosses must yet be called scant compared with the growth of these plants in the higher parts. Yet here, too, trees can be found the branches of which are covered with thick cushions of moss.

In 1890, a great number of trees in Tjibodas have been numbered and materials collected by the forester KOORDERS for the sake of study of the trees in Java. In 1913, the numbered trees were re-examined and new specimens numbered.

Many trees had died or had been blown down, and thus it was necessary, in 1920, to re-examine everything; this work was carried out by the assistant-curator Mr. BRUGGEMAN. A great many new trees were numbered, and moreover, a beginning was made with the numbering of lianes and larger shrubs. The plants now numbered in the preserved part have been entered in a list; they are besides noted down on a map hung in the guest-house, so that material can be easily obtained from these plants.

The Flora of Tjibodas published by KOORDERS gives a survey of the plants occurring here. It is true that the work is not yet complete, and new species are indeed being found again and again, but with the help of this work, it is easier to orient oneself than is possible in most primeval forests.

The first part of the wood bordering on the garden still contains many elements escaped from the garden, besides some imported plants from other regions which have penetrated the wood, especially along the paths; if the paths are abandoned and the jungle is entered, a vegetation will be found existing almost entirely of species of native plants.

The road first goes down through a ravine, in which are waterfalls. Before reaching this highest point the path first leads through a swamp,

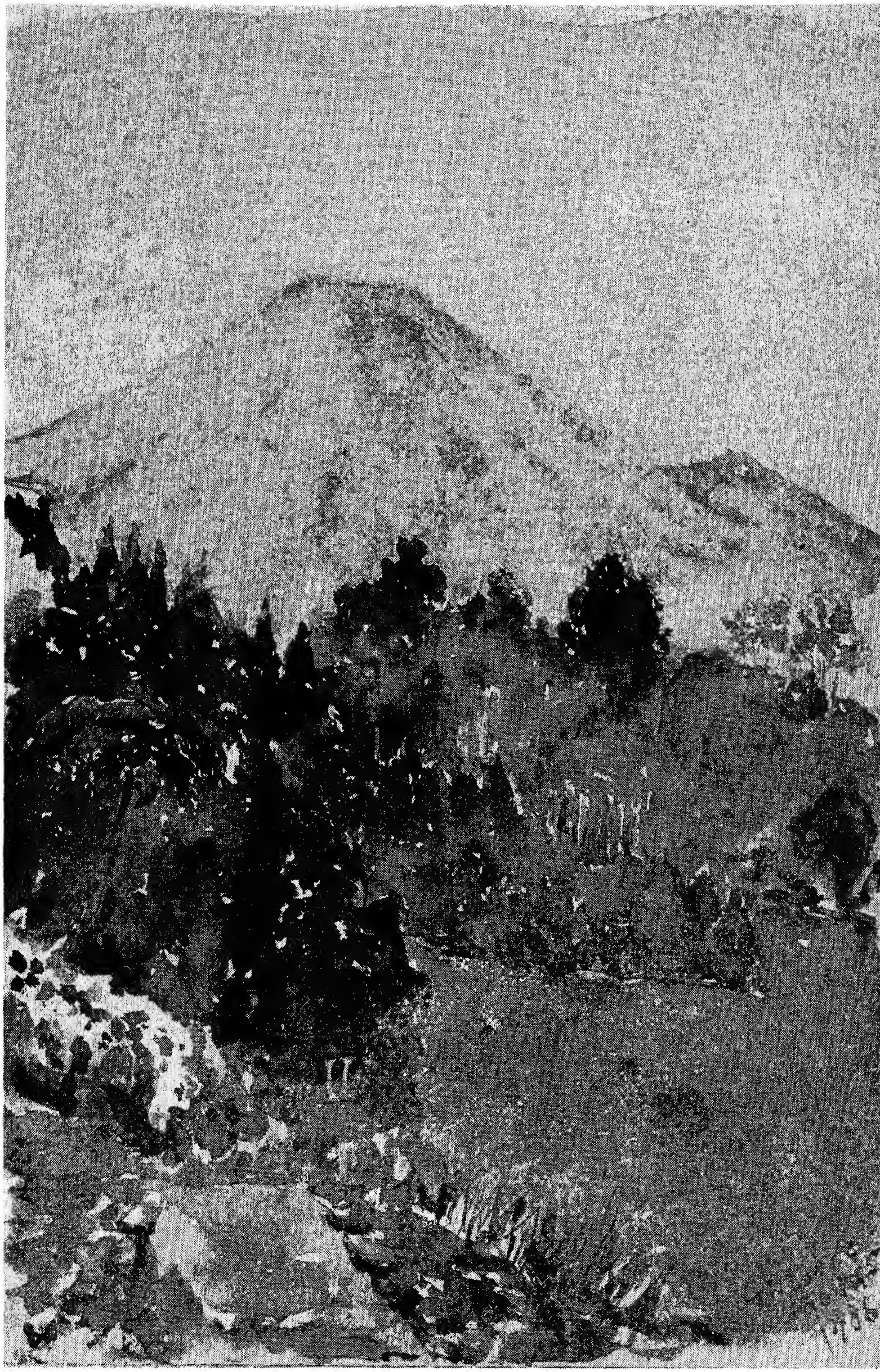

FIGURE 115. — MOUNT PANGERANGO, A BEAUTIFUL EXTINCT VOLCANO WITH A VERY RICH VEGETATION. In this district a considerable area of primeval rain and mountain forest has been set aside as a nature reservation. Water color by Professor D. H. CAMPBELL (*cf.* Fig. 109).

in which only few trees occur. Many grasses grow here, amongst others the *Phragmites Karka* TRIN., also much found in marshy spots in the lowlands. Between the grass grow some herbs and shrubs and small arborescent *Ericaceae*, such as *Vaccinium laurifolium* MIQ.; also *Gunnera macrophylla* BL. occurs here.

Going down from the highest point, a very damp part is reached with brooklets running everywhere, and swamps. Very common in this part are some *Zingiberaceae*, amongst others *Phaeomeria solaris* SCHUM. and *Hornstedtia paludosa* VAL. Also *Nepenthes gymnamphora* NEES is locally very common here, part of the chalices are high up in the trees on the branches of this liane, part of them are on short branches on the floor of the forest hidden in fallen leaves.

These chalices are red stained and always contain many captured animals; the aerial chalices are green; not so many animals are caught in them.

The three waterfalls of the Tjibeureum dash down from a perpendicular wall of 40–50 m. high. This wall is covered with many mosses, amongst which also *Sphagnum* and on some spots a luxuriant vegetation of *Elatostema*-species and *Gunnera macrophylla* BL. has arisen. On the stony slope covered with forest, some plants are found, which generally occur much higher up in the mountain range, amongst others *Ranunculus diffusus* DC. and *Gaultheria leucocarpa* BL. Moreover, staunch shrubs of *Rhododendron javanicum* BENN. are found here, occurring in the neighbouring forest as an epiphyte in the trees, here growing on the ground. Large specimens of *Cyrtandra coccinea* BL. are common here and there. The imported *Eupatorium pallescens* DC., one of the most troublesome weeds of Western Java, here too ousts the original flora and must continually be cut away.

From the highest point, from where we have descended into the ravine with the waterfalls, the path leads further up to the summits of the two volcanoes mentioned, the Gedeh and the Pangerango. As there will be no time to make these two excursions, it may be sufficient to mention, that a hot shower-brook is passed at 2200 m. altitude, of which the water has a temperature of about 48–50° C. emitting large clouds of vapour. From this point the vegetation, which also below this altitude showed distinct changes, begins to merge more and more into the so-called alpine wood. The trees are getting smaller and thinner, the number of species smaller, the lianes too are getting less numerous, only the *Podocarpus imbricata* BL. occurs in very large specimens up to beyond Kandang Badak situated at an altitude of 2400 m. A luxuriant development of various moss-species covers the soil and coats all trunks and tree branches with thick cushions.

The number of epiphytes likewise decreases, and having reached Kandang Badak the alpine forest, which is poor in species, is traversed. Below and round Kandang Badak *Quercus* species still occur. Higher up, it is chiefly *Vaccinium*, *Astronia spectabiles* BL., *Rapanea aveni*, MEZ., *Ardisia javanica* DC., *Leptospermum javanicum* BL., *Symplocos sessilifolia* GÜRKE, *Elaeocarpus acronodia* MAST., *Eurya acuminata* DC. and *Polyosma ilicifolia* BL. which are common. The ground is covered with various herbs and shrubs, *Polygonum*-species, *Rubus*-species, *Pilea trinervia* WIGHT, *Elatostema paludosum* MIQ., *Ranunculus diffusus* DC., *Disporum pullum* SALISB., and many others. Of the ferns especially the *Lomaria* species strike the eye, growing in dense vegetation on the ground; and many epiphytical *Polypodia* as well as various *Lycopodia* and *Lygodia* form dense jungles. The parasite *Balanophora elongata* BL. is also common.

Near Kandang Badak, *Albizzia montana* BTH. with the big galls formed on it by a *Uromyladium* is common, and it can also be found on the summit of the Gedeh. On the summit of the Pangerango this species of tree does not occur, also not *Myrica javanica* BL., which is frequently found on the Gedeh. Conversely, the famous *Primula imperialis* JUNGHN., found by JUNGHUHN on his first ascent of the Pangerango in 1839, is not present on the Gedeh. The forest extending up to the summit of the Pangerango remains a genuine moss-forest, only the summit and the subsidence behind are more or less bare and covered with alpine shrubs and herbs. Common are *Hypericum Leschenaultiana* BL., *Rubus lineatus* REINW., *Anaphalis javanica* SCH. BIP., *Ranunculus javanicus* REINW., *Thalictrum javanicum* BL., *Swertia javanica* BL., *Laurembergia coccinea* KAN., *Polygonum chinense* L., *Schefflera rugosa* HARMS., *Gaultheria* spec. div. and others.

Some grasses such as *Agrostis Reinwardtii* V. H., *Poa annua* L., *Isachne pangerangensis* Z. ET M. and the sedge, *Carex hypsophila* MIQ., cover the bare places. In this part TEYSMANN laid out a garden, remnants of which can still be found in the *Fragaria* species spread everywhere, in the little shrubs of *Rubus fructicosus*, in the apple trees and the beech, which, although 100 years old, has not developed beyond a small shrub. The higher slopes of the Gedeh are covered with younger wood, and on the trees thereof few mosses have attached themselves. On the stony crest and on the slopes of the crater, there grow but a few plants, and all of them as small specimens such as *Vaccinium varingifolium* MIQ., *Rhododendron retusum* BENN., *Gaultheria leucocarpa* BL. and *fragrantissima* WALL., *Myrica javanica* BL., *Anaphalis javanica* SCH. BIP. and *Albizzia montana* BTH. Between the stones grows much *Pleopeltis Feei* V. A. V. R.

The list of numbered trees offered to the guests at Tjibodas presents a survey of the species occurring in the preserved part, moreover a herbarium of the plants of the preserved part, though as yet incomplete is present in the laboratory.

This primeval forest is very rich in all kinds of species of plants — so rich that a very extensive field for study is still available for years to come. *Algae* occur commonly in the brooks and stagnant parts; they are also to be found in the shower-brook.

*Fungi* are very abundant, the lower as well as the higher mushrooms. Parasitic fungi also occur in the forest. The abundance in *Hepaticeae* and *Bryophytes* is overpowering, and ferns too, are found on the ground as well as on trunks of trees and branches of arborescent *Cyatheaceae*; even *Hymenophyllaceae* can be found everywhere. Of the taller plants the following families come to the fore.

Three *Gymnosperms* belonging to the *Taxaceae*, namely species of *Podocarpus*, occur here. Particularly the *Podocarpus imbricata* BL. can develop into a regular forest-giant, not second to the Rasamala tree in dimensions, and growing much higher on the slope of the mountains.

Of the *Pandanaceae* the *Pandanus furcatus* ROXB. is very common, and moreover 3 species of climbing-plants from the genus *Freycinetia* occur. The *Graminae* are represented by comparatively few species, in the genuine virgin forest they are lacking for the greater part, except along the paths. More species occur on the higher parts of the two volcanoes. The *Cyperaceae* are not common either. *Carex baccans* NEES occurs everywhere and is conspicuous on account of its red fruit. Only two kinds of rattan-palms grow in the forest, and also an arborescent palm: *Pinanga Kuhlii* BL. Of the *Araceae* some climbing-plants belonging to the genus *Raphidophora* are found, and some species of *Homalomena* and *Schismatoglottis* growing on the ground. *Arisaema filiforme* REINW. can be found everywhere, and here and there *Amorphophallus spectabilis* ENGL. Also some *Commelinaceae* e.g. *Forrestia mollissina* KDS. f. *glabrata* HASSK. are common in the lower part of the forest.

*Liliaceae* and *Amaryllidaceae* are represented by only a few species. *Disporum pullum* SALISB. and some *Dianella* species, further *Curculigo* in the lower part are the principal ones. Of the *Zingiberaceae*, some species are conspicuous locally on account of their large dimensions and the number of specimens; they are chiefly *Amomum coccineum* BL., *Phaeomeria solaris* SCHUM. and some *Zingiber* species. As to the number of species, all these families of monocotyledons are far out-numbered by those of the *Orchidaceae*. About a quarter of the orchids occurring in Java can be found at Tjibodas. Among them are genuine saprophytic soil-forms, such as *Epipogum nutans* RCHB. F., as well as many terrestrial forms with green leaves. More numerous still are the epiphytes, more than 100 species thereof have already been found. Especially of *Dendrobium*, *Bulbophyllum*, *Eria*, *Appendicula*, *Oberonia* and *Liparis* many species are present.

Of the *Dicotyledons* only some of the best known families can be stated. Some climbing and some shrubby and herbaceous *Piperaceae* occur; *Piper baccatum* BL. belongs to the largest lianes. The *Fagaceae* are important among the tree species; *Castanea* and *Quercus* species are common and belong to the tallest trees. Of the large family of the *Moraceae* the genus *Ficus* is represented by 18 species. The forest-giant *Ficus involucrata* BL. forms splendid specimens, strikingly common is *Ficus ribes* REINW., and among the climbing species *F. punctata* THBG. The epiphytic *F. cuspidata* REINW. species is also present everywhere. Many *Urticaceae* occur, various *Elatostema* species cover the soil locally and are particularly to be found along the brookbanks. *Villebrunnea rubescens* BL. is an arborescent shrub frequently run across. In the tops of the trees *Loranthaceae* commonly occur, the *Loranthus axanthus* HORSF. was lately only known from Borneo and belongs here to the most frequently growing species of the lower forest. *Polygonaceae* are represented by some *Polygonum* and *Rumex* species. *Polygonum chinense* L. is common from the lowest part up to the mountain-tops.

Of the *Ranunculaceae*, with the exception of *Clematis* species particularly occurring in the higher regions, *Ranunculus diffusus* DC. and *javanicus* REINW., and *Thalictrum javanicum* BL. are named here.

Very important is the *Lauraceae* family, as many species of the genus *Litsea* occur here. To the *Hamamelidaceae* belongs the well-known forest-giant, the Rasamala, *Altingia excelsa* NOR., growing especially in the lower parts. Of the *Rosaceae* some genera, such as *Rubus*, *Neillia* and *Photinia*, which can be locally common, particularly in the higher parts, are named. The *Leguminosae* family is of relatively small importance in the preserved part. Of the *Rutaceae* a tree-species *Acronychia laurifolia* BL. and the lianes *Fagara* and *Toddalia aculeata* PERS. are common. Also the *Euphorbiaceae* are represented by few species, most frequent is the small tree *Homalanthus populneus* O.K. An *Aceracea*, *viz.* *Acer niveum* BL., grows as high as Kandang Badak, and is very common. Many *Elaeocarpus* species occur in the wood, and some species reach the mountain-tops. Of the *Dilleniaceae* a number of *Saurauja* species are well known. The *Theaceae* are represented by some *Eurya*-species and particularly by *Schima Noronhae* REINW., the latter species is found up to great heights. Various *Begonia* species, such as the splendid *Begonia robusta* BL., occur in the forest. Of the *Myrtaceae*, several *Eugenia* species are common.

On the tops of the volcanoes grows *Leptospermum javanicum* BL., in Java occurring only on some mountains in the western part. Various epiphytic *Melastomataceae*, *Medinilla* species and the arborescent *Astronia spectabilis* BL. are to be found. Many *Araliaceae* belonging to the genus *Schefflera* and *Macropanax*, partly growing epiphytically, are conspicuous. On the highest mountain-tops is found *Schefflera rugosa* HARMS., while *Schefflera lucescens* KDS. grows in the alpine forest as a liane. To the *Ericaceae* belong the well represented *Vaccinium*, *Gaultheria* and *Rhododendron* genera, occurring partly epiphytically, partly terrestrially. Of the *Myrsinaceae*, species of *Rapanea* and *Ardisia* are found; of the *Primulaceae*, *Primula imperialis* JUNGH. is common only on the top of the Pangerango. Some *Gentianaceae* belong amongst others to the flora of the high mountains, such as the small *Gentiana quadrifaria* BL. and the creeper, *Crawfurdia trinervis* HASSK.

*Labiates* are rare, only *Coleus galeatus* BTH. is to be found everywhere in the lower part. Many *Gesneriaceae* occur in the forest, the epiphytic *Aeschynanthus* species and the shrub-shaped *Cyrtandrae*; of the *Acanthaceae* is particularly stated *Strobilanthes cernuus* BL., which shrubby herb blooms about every 7 years and is at the time entirely covered with the white flowers. The number of *Rubiaceae* is very numerous, about 28 species occur here. Of the *Caprifoliaceae*, the species of *Viburnum* and *Lonicera* attract attention; they are to be found up to the highest parts. There also grows the herbaceous *Valeriana Hardwichii* WALL. *Compositae* are not common, except the tree-species, *Vernonia arborea* HAM. On the bare summits grow, *Anaphalis javanica* SCH. BIP., *Myriactis nepalensis* LESS., and a *Dichrocephala* species.

According to KOORDERS' report, there were known in 1914: 165 tree-species, *viz.* 29%; 350 shrubs and herbs, *viz.* 61%; and 60 climbers, *viz.* 10%, which makes a total of 575 phanerogamic species.

# The Tjibodas Biological Station and Forest Reserve

## IV, THE BOTANICAL GARDEN AT TJIBODAS

*by*

P. Dakkus *

*Curator of the Botanic Gardens, Buitenzorg, Java*

This garden, a branch-establishment of the Buitenzorg Botanic Gardens, is situated on the slopes of the volcanic Mount Gedeh, at an altitude of about 4500 feet. It lies about sixty miles from Buitenzorg, and is reached by train to Tjandjoer, from which station a motor car drive of about one hour brings one to Sindanglaja. From the latter place a footpath leads uphill to Tjibodas or "white brook," which is about an hour-and-a-half's walk distant.

On entering the garden a curious odour greets the visitor; this is caused by a kind of grass, *Melinis minutiflora*, Beauv., which grows along the side of the path. A little way beyond the entrance a fine view is obtained over the whole garden. In the foreground is a little lake, with white swans, and surrounding this are wide lawns, dotted here and there with groups of Conifers and other handsome trees. In the background stand the mountains, bushclad almost to their summits, the whole making a picture, the equal of which one may travel far to find.

Across the lawn, by the main path, is a little stone-paved avenue, planted on both sides with *Araucaria Cunninghamii*, Ait., and *A. Bidwillii*, Hook., commonly known as Richmond River or Hoop Pine and Norfolk Island Pine. These Araucarias, natives of Australia, were imported many years ago, and have now grown into very tall trees, some having a diameter of three feet, at three feet from the ground. The boughs hang very low, and the intense shade makes the avenue a little gloomy in the rainy season. Near the end of the path stands the resthouse, with the house of the Assistant-Curator on the left, and a little further away is the spacious laboratory.

The garden, which previously had been used as an experimental plot for *Cinchona*, was founded in 1866 by Mr. J. E. Teysmann, at that time Curator of the Buitenzorg Botanic Garden. It is set apart for such plants as are unable to withstand the warmer climate of Buitenzorg; more especially for those which are collected in the higher regions of our own colony. It is also used for those imported from subtropical regions for economic or ornamental purposes.

The most important part of the garden, however, is the forest-reservation, especially that portion which immediately surrounds the garden. It is real virgin, tropical, mountain jungle, through which paths have been laid out. It was Dr. Koorders who first conceived the idea of naming and labelling some hundreds of the more important trees in this reserve. These labelled specimens are scattered over an area of about 800 acres. It is a piece of work which has been of the greatest assistance to botanists who have come to study the tropical mountain flora of this country, and so much has it been appreciated, that in recent years we have had to extend the work considerably, and now have upwards of 400 such named plants. One small portion of the forest has been set apart for herbs, mostly from the adjoining forest. This method of naming specimens has been of great assistance to visiting botanists, who are thus enabled to become acquainted with our mountain flora before they actually begin their expeditions into the jungle. The entire forest-reservation reaches to the peak of Mount Pangerango (9068 feet), and to the summit of Mount Gedeh (8886 feet), and covers an area of several thousand acres.

The resthouse was built in 1891 and contains four bedrooms, a dining-room and a sitting-room. It is reserved for visitors who come for scientific purposes; the well-furnished laboratory is also for the use of research workers.

Opposite the resthouse two curiously shaped trees, each standing about twenty feet high, bear a ball-shaped crown, consisting of long, slender, stiff, grass-like leaves. The trunks carry the remains of the old leaf-stalks, and between these oozes out a kind of resin, used by our natives as a medicine for certain skin diseases.

These are specimens of *Xanthorrhoea Preissii*, Endl., natives of West Australia, where they grow abundantly in wet places, such as the Swan River Valley. They are commonly called "Grass Gum trees" or "Nigger Heads," the crown having the appearance of a bunch of grass or a native's head. On the same plot are some fine examples of *Yucca*, *Cordyline*, *Dasylirion*, and a big plant of *Doryanthes Palmeri*, W. Hill, the latter also a native of Australia and a very decorative garden plant. A little further to the left grows a curious plant from Chili, *Colletia cruciata*, Gill. et Hook. f.; at first sight this appears to be a dead, spiny shrub but on looking closer it is seen to be alive and even bearing little, white, sweetly-scented flowers.

On the same side is the entrance of the Fern and Orchid garden containing very many fine Tree Ferns and Orchids, the latter growing chiefly on the stems of a native *Alsophila*, which grows abundantly on the mountain slopes of Java.

A plant well-known in European gardens, *Cobaea scandens*, Cav., grows along the edge of the forest. This climber, introduced many years ago, has run wild, and now covers with its violet and yellowish-white flowers all the shrubs and smaller trees which grow along the margin of the big bush.

From near the little summer house an unobstructed view is obtained over the lower garden, with the mountain group in the back-ground. Groups of *Casuarina*, *Araucaria*, *Cupressus* and *Pinus* give the landscape a European character, as also does a little Pine wood, which contains many interesting and little-known species of Pinus. Amongst these are *Pinus Montezumae*,

* Reprinted, with kind permission from the *Gardeners' Chronicle* III, 79:270–271 and 286–287 (1926).

Lamb., from the Himalaya; *P. insularis*, Endl., from the Philippine Isles; *P. canariensis*, C. Sm., *P. australis*, Dum.-Cours., *P. palustris*, Mill., from north America, and several others.

Beyond the Pine wood is a group of various species of *Eucalyptus*, mostly natives of Australia. They are magnificent trees running up to over one hundred feet in height, and carrying their branches far above the surrounding growth. This collection contains specimens of *Eucalyptus regnans*, F. v. Muell.; *E. saligna*, Sm.; *E. capitellata*, Sm.; and *E. maculata*, Hook. f., var. *citriodora*, v. Muell. From the leaves of the last-named species an oil is distilled, the smell of which strongly recalls citronella. Other fine *Eucalyptus* growing here include *E. corymbosa*, Sm.; *E. eugenioides*, Sieb.; *E. erythronema*, Turcz.; *E. microtheca*, F. v. Muell.

A fine collection of Japanese Bamboos next attracts attention; some, such as *Phyllostachys sulphurea*, A. et C. Rivière, have yellow stems; others, such as *Phyllostachys nigra*, Munro, have black stems. In Japan most of these Bamboos are used for basket work and walking-sticks, but in Java they only serve for ornamental purposes. Beyond these lie the flower-terraces, where different varieties of flowers for cutting and garden purposes are cultivated. Near by is a little water garden containing several small ponds wherein goldfishes live their quiet life and Water Lilies and other aquatic plants grow . . .

The most important part of the garden is, as already mentioned, the forest reservation, which is entered by several tracts. From these tracts by-paths lead to labelled trees which cannot be seen from the main track, thus enabling every tree to be studied individually. The visitor who for the first time enters such a tropical jungle, gets a wonderful impression of the immense variety of the vegetation. Trees, shrubs, herbs, lianes and epiphytes together make a dense, impenetrable jungle, and the newcomer is overwhelmed by the magnitude of the task before him, ere he becomes acquainted with the various species here represented.

FIGURE 116. — THE BIOLOGICAL LABORATORY IN THE MOUNTAIN GARDENS OF THE GOVT. BOTANIC GARDENS AT TJIBODAS, NEAR SINDANGLAIJA, WEST JAVA. — Built in 1920.

One of the first trees to attract attention is the Rasamalah (*Altingia excelsa*, Noronh.). This has a greyish, slender stem, and often reaches a height of 150 feet, bearing its branches far above the surrounding trees, and forming a landmark which can be seen from many miles away. On the branches of this, and, in fact, of all the trees in this moist region, are long, hanging clusters of a greyish-green Lichen (*Usnea*), which softly swing to and fro in the breeze. This Lichen is often called Beard Moss, or Old Man's Beard, because of its resemblance to the long, white beards of the hobgoblins of our childhood. The Rasamalah is one of the best timber trees of the mountains, and is generally used for buildings in this country. Other common trees are three kinds of Sweet Chestnut, which bear edible fruits. They are *Castanea argentea*, Bl.; *C. javanica*, Bl.; and *C. Tungurrut*, Bl. There are also several species of Quercus or Oak (*Quercus*). All these trees often attain astonishing dimensions and reach a height of 100 to 120 feet.

In addition to the foregoing, members of the

families *Lauraceae* and *Leguminosae* are scattered over the forest. Amongst the former the genera *Cinnamomum*, *Litsea* and *Phoebe* contain some of the tallest trees of their family, whilst amongst the *Leguminosae*, only two attain arboreal dimensions. One of these is *Albizzia montana*, Benth., which grows to a height of about twenty-four feet, and is found up to an elevation of 6000 feet. *Euchresta Horsfieldii*, Benn., a shrub belonging to the same family, is only known from the Himalayas, the Philippine Isles, Formosa and Java, where it is found very rarely at an altitude of between 4000 feet and 6000 feet. The very bitter seeds, which are used by the natives as a medicine for chest troubles and consumption, contain the alkaloid cytisine, and are therefore of very doubtful value.

The family of the *Taxaceae* contains the genus *Podocarpus*, represented here by *P. amara*, Bl., which often reaches a height of 120 feet with a diameter of four feet. Another species, *P. imbricata*, Bl., grows up to an elevation of 5000 feet, and in the saddle, between Mount Gedeh and Mount Pangerango, this tree and *Schima Noronhae* are the tallest trees growing at this altitude. In the jungle undergrowth many remarkable plants are found, and amongst them the different kinds of *Melastomaceae* are conspicuous. The plants include *Omphalodes fallax*, Naud., a white-flowering species; *Dissochaeta intermedia*, Bl., with reddish flowers and violet fruits; *Medinilla laurifolia*, Bl., with reddish inflorescences; and *M. speciosa*, Bl., also reddish. The young fruits of this last are reddish-white, but later turn dark violet with purple fruit-stalks. In the family of the *Liliaceae*, *Dianella ensifolia*, DC., which bears blue flowers, and, later, dark blue fruits, is worth mentioning.

In the Palm family the different kinds of Rattan deserve mention. They are most remarkable adaptations, which, forsaking the typical habit of Palms, become climbers. They ascend the highest trees and make the forest impenetrable on account of their spiny leaves, the thorns of which are recurved. It is impossible to make a way through the dense jungle thus formed without the assistance of a strong hunting knife. One of these Rattans, *Plectocomia elongata*, Bl., has stems with a diameter of three inches, and a length of about 200 feet. It is the giant of its group. The young leaves are covered with a white powder, while the young stems have a thin film of wax. Still more striking are the flower-spikes, which have a length of three feet and are of a deep brown colour. They may be used most successfully for decorative purposes, especially for large rooms. The only non-climbing Palm found at this elevation is *Pinanga Kuhlii*, Bl., which averages about ten feet in height, but specimens up to twenty feet are sometimes met with. This Palm suckers freely from the roots and forms small thickets. In places where the growth is less dense *Alsophila* finds a place, and its broad crowns, with their delicate fronds give a graceful touch to the landscape.

The Tjibeureum Falls are reached after a two hours' walk, ascending and sometimes descending the very steep path. These are situated at a most beautiful spot at an elevation of 4700 feet, and consist of three falls coming down over a wall of rock with a fall of nearly one hundred feet. The middle fall is the longest, and also carries the largest volume of water. Words fail to describe the beauty of this enchanting spot; the luxuriant growth of Ferns and Mosses which covers the stones, and the sparkling water running through them makes a scene one seldom meets. This is also one of the places where a kind of Sphagnum-moss grows. It is used for Orchid culture here in the same way as in Europe.

Beyond the falls the main path becomes very steep, consisting, in some places, only of loose stones. It leads either to the crater of Mount Gedeh or to the summit of Mount Pangerango. Along the edge of the track many interesting plants are to be noted. One of the most remarkable of these is *Nepenthes melamphora*, Bl., many varieties of this group are cultivated in European glasshouses. The species found here is very abundant, and often climbs ten feet or more up the adjoining trees. In some cases, however, it remains on the ground. In such cases the pitchers are buried in the moss, so that their opening is on a level with the moss-surface. The object of this is to entrap insects creeping on the surface of the moss; these wanderers fall into the traps whose slippery walls render it impossible for them to climb out again, so that they are drowned in the liquid which the pitchers contain. In the climbing forms the pitchers are rather rare in the lower portions, but higher up they are produced in large numbers. Here nature has the same object in view, for there are fewer insects low down than near the tops of the trees, where the flowers appear.

The abundance of Orchids is astonishing. True, not all are large-flowering species, but, nevertheless, they are most interesting, and include *Oberonia*, *Appendicula*, *Agrostophyllum*, *Phaius*, *Dendrobium* and others. Climbing higher, epiphytical Mosses and Lichens become more abundant, while Ferns of the *Hymenophyllaceae* group become much in evidence, showing that the mist-belt has been reached.

Some hot springs are passed at an elevation of 6270 feet. These springs come out of a rocky wall on the left and flow down into a deep ravine on the other side of the track, producing clouds of steam and making the path slippery and hard to find. Some distance beyond the springs is a cabin, built for travellers to pass the night in, or for the botanist who has to stay here for his scientific work. The name of this cabin is "Kandang Badak," meaning "rhinoceros shed," because in former times this was said to be a favourite place for this animal! But the rhinoceros is a thing of the past in Java; many other animals have had to give way to the advance of cultivation, although wild boars are very numerous in the district, and an occasional panther is to be met.

A little beyond this point the forest gradually changes its character, and near the summit of Mount Gedeh the vegetation consists only of stunted trees, with stems and branches covered with thick Moss-cushions. Most of these trees belong to the *Ericaceae*, such as *Rhododendron*, *Gaultheria* and *Vaccinium*. After a short time the erratic boulder field is entered and a fine view of the crater of Gedeh is obtained.

# WILD LIFE CONSERVATION IN THE NETHERLANDS EMPIRE, ITS NATIONAL AND INTERNATIONAL ASPECTS

*by*

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## *Introduction*

Wild life conservation is world-wide, but comparatively new, having been started as recently as the beginning of the present century. It is one of the hopeful, human reactions to the materialism of the past decades. In general, conservation aims to protect all natural life, both animal and plant, against needless destruction. One realizes the urgency of conservation after reading H. F. OSBORN and H. E. ANTHONY's book, written in 1922, with the alarming title *Close of the Age of Mammals*. Needless to say, it is most dreadful and scandalous that we, the enlightened people of the twentieth century, should witness the end of the age of mammals, a termination we ourselves have caused. Remember the terrific slaughter of the North American buffalo, the startling decline of the African mammals. Recall the insatiable demands of the fur industry, and the methods of modern whale fishing and seal hunting. These are some of the factors responsible for the extinction of animal life.

Nor does the fate of the birds seem to be much happier. The fashion for ladies' feather hats and feather trimmings of recent years has caused ruthless killing of millions of the most beautiful and interesting creatures. Moreover, the destruction of large forests and the resultant erosion and impoverishment of the soil has caused great losses of animal and plant life — besides having been an economic detriment.

And we could give many more examples of man's mismanagement of his earth.

It may be argued that wars between peoples — of which the most terrible is now in progress — is more proof of man's lack of management than is the destruction of wild life. Nevertheless, we should not close our eyes to man's mistreatment of Nature's creatures. To create a true civilization, we must advance in all ways simultaneously; progress in one field will not be permanent if similar advances are not made in other areas.

Wild life conservation has many aspects. There is the ethical side, by which we mean respect for Creation. There are aesthetic values, exemplified by the name of the well-known zoological garden in Amsterdam, "Natura Artis Magistra" (Nature is the teacher of the Arts). The scientific side is seen in the aim of preserving as many forms of natural life as possible for purposes of study. And last but not least, there is the economic side which involves the important need of keeping our natural wealth intact for many generations to come.

Speaking of scientific aims, we can best quote the warning words of the late Swiss professor PAUL SARASIN, well-known explorer of Celebes and one of the pioneers in the international movement for the protection of nature:

> "A product from human hand, let us say a product of culture, may be unique and of supreme value, but in case of its destruction there will always be the consoling thought that mankind may be able to create once again such a product of art, yes, even may surpass it . . ., never in the millenaries ahead of us a remarkable, highly organized animal species will re-occupy its place on the stage of Life after it once has been exterminated — and this is most deplorable — exterminated aimlessly and thoughtlessly."

* * *

What now is the rôle of the Netherlanders and their compatriots of the entire Netherlands empire in the movement for national and international conservation of nature? How have they organized wild life protection within their own boundaries? In what ways do they coöperate with the conservation movements in foreign countries?

The answers to these questions are the quintessence of this article.

## *National Aspects*

The number of people in THE NETHERLANDS † in Europe is small. When one considers their achievements in matters of conservation, he realizes that their performance entitles them to a place in the foremost ranks of the nations, albeit the work has been done by a comparatively small group.

Holland, with its many valuable natural reservations, is well reputed among the most civilized nations of Europe. This position we owe chiefly to private initiative, embodied primarily in the popular "Vereeniging tot behoud van natuurmonumenten" (Society for the preservation of nature monuments). The society was organized in 1905 primarily to protect the spoonbill, one of whose rare nesting places in western Europe — the Naardermeer — had been designated as a refuse dump for the town of Amsterdam. The first act of the new organization was to acquire this unique marshy land so near the capital of Holland and keep it for the birds. Since that time, the society, under the able direction of Mr. P. G. VAN TIENHOVEN, Dr. JAC. P. THIJSSE, and several others, has done its utmost for the conservation of wild life in the Netherlands.

In the course of years the possessions of the society regularly expanded until, at present, its forty-nine estates, scattered over almost all the

* *Original contribution, especially prepared for "Science and Scientists in the Netherlands Indies."*

† From time to time the name Holland has been used in this paper, instead of "the Netherlands", although the latter is the official name.

provinces of the country, comprise a total of approximately 12,000 hectares.[1] This figure may not seem very impressive when compared with the total area of Holland — slightly over 3,000,000 hectares. However, it means a splendid achievement if one takes into consideration the fact that our country, with its almost nine million inhabitants, is among the most densely populated of nations. One must remember that the large sums of money needed for the purchase of these protected areas were contributed voluntarily by the members of the society and friends sympathetic to the movement.

Several provincial and local organizations with the same aims as the large national society have also been set up. Particularly devoted to the preservation of the avifauna is the Netherlands Society for the Protection of Birds. It coöperates with Natuurmonumenten and secures the game wardens who guard the most important nesting places. Moreover, it looks after the improvement and proper observance of the Game and Bird Laws. Another group is the committee for the protection of the wild flora which looks after the interests of the native vegetation.

When one realizes how extensive a rôle the private organizations for the protection of wild life in the Netherlands played, he might wonder what the government has done in this field. It is regretted that so far Holland has not been one of the countries that have a State body primarily concerned with conservation. Unfortunately, there is no general law that could prevent all the mischief threatening the wild life of the Netherlands. The demand that "nature protection should be the object of Governmental care" has been only partially put into practice. There are, however, several laws which, more or less, serve the interests of nature. They include the Forest Law, the Law for Natural Scenery, the Bird Law, and the Game Law. The last two have recently been brought quite up-to-date. In the administration of the State Forests (Staatsboschbeheer), the government has set aside vast areas of the public domain as nature monuments; the total acreage of these state sanctuaries is almost equal to that of Natuurmonumenten. It is also true that the government has promised more elaborate regulations that would bridge the gap between private initiative and State management.

The German invasion of 1940 upset the normal development just indicated. In addition to the loss of many precious lives and the destruction of valuable historical and modern creations, it levied a heavy toll upon the birds when, for defense purposes, the waterways of North Holland, Utrecht, and Gelderland were opened. Large pastures were inundated in May, the middle of the breeding season. Both unhatched eggs and young birds were destroyed by the rising waters. One should remember that this country is the site of some of the most famous and interesting bird colonies of Europe, the Naardermeer for instance.

In other ways, too, the war and the German occupation have been hard on the wild life of the Netherlands. It is easy to understand how the increasing shortage of food has led many people to collect the eggs of birds protected by law and to violate the game regulations to secure as much as possible of the much-needed meat. Who is going to blame them? The great need of wood, with its consequent increased felling of trees, has endangered not only the forests, but the flora and fauna therein, a calamity especially in a thinly wooded country like Holland.

It is reasonable to expect that, after the liberation of Holland, the government will be thoroughly concerned with the problems of wild life conservation. At the same time, coöperation with private organizations will be established, presumably by means of the "Contact Committee for nature and landscape protection," a body which had been founded before the war as a federation of all organizations directly or indirectly concerned with the preservation of nature in the Netherlands. In our extremely densely populated country, there is too much at stake, too much of what we possess of beauty in flora, fauna, and landscape is in danger of being lost forever, for mere private initiative to avert the impending menace. Only a special conservation service based on a general law for the protection of nature, can effectively safeguard the Netherlands' treasures. In the future, we must refrain from committing any such national crimes as the quarrying of the St. Pietersberg near Maastricht in the province of Limburg, a place that was once an historical and geological beauty spot of prime importance.

* * *

Now let us see what has been accomplished in the Overseas Territories of the Kingdom.

First we shall deal with the NETHERLANDS EAST INDIES, the archipelago which, abundant in natural wealth, is a link between Asia and Australia in matters of geography, fauna, flora, and anthropology. It is not surprising that in this very area the famous scientific traveller, ALFRED RUSSEL WALLACE, carried on his pioneer investigations of the distribution of the fauna.

The first reason for taking measures to protect the fauna of the East Indies was to limit the extensive hunting of birds of paradise in New Guinea and some of the surrounding islands. As you know, during the last quarter of the nineteenth century and the first decades of the twentieth, Europe and countries on other continents "suffered" from the fashionable use of feathers on clothing. The enormous demand for ornamental feathers resulted in a terrible slaughter of the winged denizens of practically all tropical countries, particularly of birds of paradise, crown doves, and the parrots of New Guinea. Annually, bird skins and feathers worth hundreds of thousands of guilders were exported. In the years just after World War I, the export value was more than two million guilders. Of course, such wanton destruction raised objections in both the Indies and Holland. Since 1905, there has been a long series of ordinances and regulations the purpose of which was a reasonable restriction of this bird hunting. However, these efforts have been insufficient and largely ineffective. This extensive destruction of birds eventually stopped when the European fashions were modified.

But the controversy that had been aroused between the protectionists of nature on the one hand and the persons destined to profit financially (among whom the government was then one) on the other, evoked in many Netherlanders and Indonesians the thought that it is the duty of the Netherlands-Indies government to safeguard the natural treasures under her care and to protect

[1] 1 hectare is about 2.5 acres.

Figure 117. — Calcareous terraces of the Tinggi Radja, East Sumatra, a well-known nature reserve (400 m.s.m.). — After C. G. G. J. van Steenis' "Album van Natuurmonumenten in Nederl.-Indië" (1937).

them against the play of the sportsman and the greed of the trader. The hunting of the birds of paradise was a typical example of what the English-speaking people call "commercialization of game" or the ruthless killing and capturing of wild animals for profit.

It was in 1912 — seven years after the founding of the Society for the Preservation of Nature Monuments in Holland — that the pioneers of conservation in the Indies came together to establish the Netherlands Indies Society for Nature Protection with the late Dr. S. H. KOORDERS as chairman. As a result of the extraordinarily energetic activity of this group, the government proclaimed the first Nature Monuments Ordinance in 1916. Since then, many valuable tracts, large and small, have been made "nature monuments" or "game reserves" by special acts of the government.

The course of events, therefore, was different from that in the mother country. In Holland, up to 1940, conservation activities and the purchase of land for reserves were chiefly private affairs, with the State and other governmental bodies in the background watching benevolently and sometimes giving support. In the Indies, where for many years no extensive ownership of land has been permitted to non-native private individuals, the government established and administered the reservations. However, the government was actively advised and supported by a comparatively small but competent group of private societies and committees interested in conservation, in both the Indies and the Netherlands. The results of this coöperation can be clearly seen in the beautiful publication, *Preservation of wild life and nature reserves in the Netherlands Indies* by Dr. K. W. DAMMERMAN, then the director of the Government Botanical Gardens in Buitenzorg. This book was offered to the participants of the Fourth International Pacific Science Congress which was held in 1929 in Batavia and Bandoeng. It testifies, on the one hand, to the achievements of the government since the time of its awakening to the realization of the need for the protection of nature, and, on the other hand, to the preparatory work and active support of the Society for the protection of nature, work which is beyond all praise.

Those who wish to acquaint themselves with the progress of wild life conservation in the Indies are advised to consult the reports of the Indies Society mentioned. Ever since the Society was founded, these reports have been published every year or two. In recent years particularly, they have become extensive, exceedingly interesting, and beautifully illustrated volumes about nature and its preservation in the Indies. They show clearly how indefatigably the Society has tried to secure improved legislation. When it became clear that the old "Ordinance for the protection of some wild mammals and birds" of 1909 was insufficient and impractical, the Society instigated the formulation of a new game and wild animal protection ordinance. This ordinance was passed in 1924, but was effective only in Java, not the Outer Provinces. Within the limitations of this paper, it cannot be explained why this new law, even though prepared by experts, fell short of expectation. It is enough to say that after a short time it had to be basically changed.

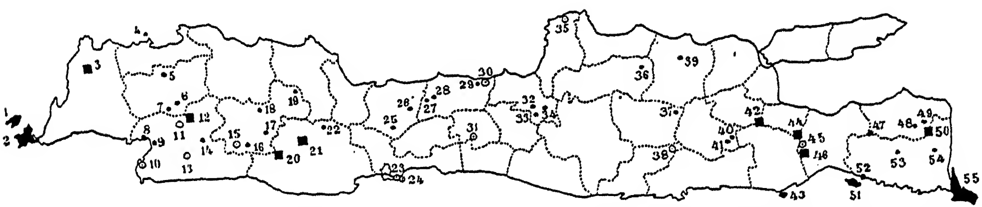


FIGURE 118.—NATURE RESERVES OF JAVA, 1929 (• Reserves of 125 acres or less, ⊙ reserves of 1250 acres or less, ■ larger reserves). 1, Prinsen Island; 2, Oedjoeng koelon; 3, Lake Danoe; 4, Klein Kombuis; 5, Depok; 6, Artjadomas; 7, Lake Tjiletoeh; 8, Soekawajana Palaboehanratoe; 9, Tangkoebanphrahoe Palaboehanratoe; 10, Tjibanteng; 11, Tjimoengkat; 12, Tjibodas Gn. Gede; 13, Takoka; 14, Tjadas Malang; 15, Telaga Patenggang; 16, Tjigenteng Tjipanji; 17, Malabar; 18, Junghuhn nature monument; 19, Tomo; 20, Crater of the Papandajan; 21, Telagabodas; 22, Koorders nature reserve; 23, North Noesa Kambangan; 24, East Noesa Kambangan; 25, Telaga Randjeng; 26, Goetji; 27, Moga; 28, Tjoeroeg Bengkawah; 29, Peson-Soebah I and II; 30, Oelolanang Ketjoeboeng; 31, Pringombo I and II; 32, Geboegan Gn. Oengaran; 33, Sepakoeng Telamaja; 34, Getas; 35, Keling 1/III; 36, Tjabak I and II; 37, Klangoen Saradan; 38, Gn. Pitjis and Gn. Si Gogor; 39, Nglirip cave; 40, Besowo; 41, Manggis; 42, Ardjoena Lalidjiwo; 43, Island of Sempoe; 44, Tengger Sand-sea; 45, Ranoe Panie Regoeloe; 46, Ranoe Koembolo; 47, Soengi Kolboe; 48, Pantjoer Idjen I and II; 49, Tjeding; 50, Kawah Idjen; 51, Noesa Baroeng; 52, Watangan Poeger I/IV; 53, Tjoramanis Sempolan I/VIII; 54, Djanggangan Rogodjampi I and II; 55, Djati Ikan and Poerwo. (*From* K. W. DAMMERMAN, Preservation of Wild Life . . . Netherlands Indies, 1929.)

Great support for the conservation movement came from the College of Delegates of the People's Council (the "House of Representatives") when that body, in 1930, unanimously passed a motion urging the government to establish more game reserves, rigorously restrict or even prohibit the hunting of certain game animals, and to prohibit absolutely their export. This motion was very influential in the passing of the entirely new Game and Wild Animal Protection Ordinances of 1931, with additional regulations, and also of the new Nature Monument and Game Reserve Ordinance of 1932.

The Game Ordinance and Regulation were again renewed in 1940–1941, but are valid only for Java and Madoera. The Wild Animal Protection Ordinance and Regulation have been supplemented several times, the last time in 1939. The Nature Monument and Game Reserve Ordinance of 1932 was supplanted by the Nature Protection Ordinance of 1941.

It is easy to see that in the vast East Indian Archipelago, where there are still large areas uncultivated, the legalizing of nature monuments and game reserves was less difficult than in the small Netherlands. Java alone, by far the most densely populated and extensively cultivated island, has reservations that cover a total of about 130,000 hectares. Sumatra and Borneo each have more, the former well over a million hectares, the latter about half a million

hectares. In New Guinea there is the large Lorentz Nature Monument of approximately 350,000 hectares that extends from the coast to the Wilhelmina top of the Snow Mountains (4750 meters). The reserves of Sumatra and Borneo are partly in territories that have indirect rule. It is satisfying to know that the native rulers realize the importance of conservation and that, as a result of their coöperation, the Wild Animal Protection Ordinance is equally valid in territories under direct and indirect rule.

The care of the government is also seen in the appointment of a special civil servant occupied exclusively with matters of the protection of nature.

However, readers who, after perusing the foregoing paragraphs, think that nature in the Netherlands East Indies is protected and safeguarded once and for all are mistaken. Before we can reach that goal, an enormous amount of work must be done. The Game Ordinance, valid only for Java and Madoera, should be applied to the Outer Provinces. The supervision of the observance of the ordinances and rules and the guarding of the reservations leave much to be desired. Many large animals, particularly the rhinoceros and elephant, are still in danger of extinction. On the other hand, we may be glad that for the orangutan, one of the most interesting objects of fauna protection, a safe future is expected, thanks to strictly observed hunting and exporting prohibitions and to the establishment of large sanctuaries in Sumatra and Borneo. The same condition is true for the other apes of the Indies, the gibbons.

A strong urge to proceed along the road to further improvement of the conditions of wild life of the Indies comes from the growing interest and the constructive criticism from abroad, particularly from Britain and North America. This clearly shows that the preservation of the flora and fauna of the East Indies is of international, as well as national, significance. As H. J. COOLIDGE, at one time the secretary of the American Committee for International Wild Life Protection, said, "The Dutch have made great progress in organizing their Nature Protection in the Netherlands East Indies, but even so, a great deal remains to be done."

FIGURE 119. — A HERD OF *Cervus hippalaphus* CUV. IN THE HIANG RESERVE (East Java). — *After* C. G. G. J. VAN STEENIS' "Album van Natuurmonumenten in Nederl.-Indië" (1937). *Cf.* also JUNGHUHN's classical description (Java 3:1069–1109).

Unfortunately, the Japanese occupation of the Netherlands Indies in the beginning of 1942 interrupted this progress. One cannot yet trace the full consequence thereof, but may readily assume that it means a serious setback.

Before we leave the consideration of the East Indies, let us look at the protection of the mountain Papuans in Central New Guinea. Before the war, voices in Holland cried out that the rapidly advancing economic penetration on this island menaces the survival of the primitive population. It is the government's task to protect these tribes against the very real danger of a too-sudden, uncontrolled contact with modern civilization. The creation of a temporary Papuan reservation would be one means of averting this danger. Of course, the problem of the protection of

primitive peoples is connected only indirectly with that of the protection of wild life; it is much more complicated.

The Netherlands territories in South America and the West Indies will be dealt with more briefly.

SURINAM (Netherlands Guiana), thinly populated and wooded, still has no conservation laws nor game sanctuaries — so far as the writer knows. There seems to be no urgent need for large-scale action as yet. Nevertheless, some people have taken a strong interest in the matter of local wild life conservation.

More urgent is the need for wild life protection in the small and rather densely populated island of CURAÇAO and other islands that belong to its government. However, thanks to the Regulations of 1926, 1931, and 1934 — to consider only the principal ones — there remains little danger that the interesting small deer in Curaçao, the curious flamingos in Bonaire, and the beautifully feathered troupials in all three Leeward Islands will be exterminated. These regulations, which prohibit the killing and capture of animals and birds and the destroying of nests and eggs, also protect several other species of birds which are "useful for agriculture and fruit culture" or "that become gradually extinct in this territory, and the preservation of which is desired." Proper control of the remaining wood lots (there is hardly a real forest, at least in the Leeward Islands, but in some of the Windward Islands there are remnants of true tropical forests) would certainly create better living conditions for the small but typical Netherlands West Indian fauna.

### *International Aspects*

So far, we have considered the national conservation of wild life in the Netherlands and the Overseas Territories. However, Netherlanders have in no way limited their activities to the boundaries of the realm.

One of the most important events in the international movement for the protection of nature was the establishment of the Netherlands Committee for International Nature Protection in 1925, at the instigation of Mr. P. G. VAN TIENHOVEN, one of the founders of the much older Society for the Preservation of Nature Monuments. This committee is a small, non-official group of influential Netherlanders who study the international problems of wild life preservation. It communicates with the respective governments of Holland proper, the Netherlands East and West Indies, and in addition it supports and promotes efforts to improve foreign wild life protection. By means of its "Communications," of which some twelve have so far been published, the committee keeps those interested informed about the work accomplished and the general status of wild life conservation all over the world. Naturally, the activities of the committee are devoted mostly to the Netherlands Overseas Territories. It was this Committee which, next to the Indies Society, always has spoken strongly in favor of the preservation of tropical wild life, and whose advices and propositions more than once were accepted by the Netherlands Indies government. Among other things, we are indebted to the unabated energy of the Committee for the establishment of the extensive Goenoeng Leuser game reserve in the Acheen, a refuge for the large mammals of North Sumatra.

Similar committees have been organized in other countries. Altogether, they constitute a kind of detective and admonitory service for the international movement for wild life protection. With the help of several of these committees, there was established in Brussels in 1928 the "Office international de documentation et de corrélation pour la protection de la nature." This office should be looked upon as a central information bureau. Its chairman was a Netherlander, Mr. P. G. VAN TIENHOVEN, the president of the Netherlands Committee. For his work in this capacity, this noted personality was awarded the "Grande Médaille de Vermeil du Gouvernement de la Société d'Acclimation de France," the ceremonial awarding of which took place in Paris in 1930. Many eminent scientists were present.

The Netherlands government soon became convinced of the importance of the Office in Brussels. It decided to give moral and financial support, the latter being an annual subsidy. It should be noted that Holland is one of the few countries which coöperate in this way. A few years later it appointed four official representatives to the Bureau, for both the Netherlands and the Indies.

Nor was the interest of the Netherlands' authorities restricted to support of the Office in Brussels. Long before that, our country, willing to take its share in an international organization for the protection of wild life, had joined other nations in the "Commission consultative pour la protection internationale de la nature", created in 1913 at the instigation of Dr. PAUL SARASIN. Unfortunately, this coöperation was "nipped in the bud" by the outbreak of war a year later.

Nevertheless, in 1917 neutral Holland joined the Convention of Paris, organized in 1902, the aim of which was to carry out measures to protect the birds useful for agriculture. In the long run, this Convention did not prove a success, but it is to the credit of the Netherlands' bird lovers that they have striven energetically for an improvement of the Paris regulations. At the International Nature Protection Congress of 1931 — at the time of the Colonial Exposition in Paris — the official Netherlands' representative proposed a fundamental change in the old, inadequate Convention.

In the meantime, Europe had witnessed several international meetings that had considered a more efficient protection of the avifauna Needless to say, Holland was actively represented at these conferences by either a spokesman of the government or a member of the societies for nature and bird protection. This was the case at the meeting in 1922 where the International Committee for Bird Preservation was proposed by the United States of America. Several Netherlands' organizations joined this Committee. They were present also, in 1926, at the conference for combating oil pollution of the sea — the cause of the deaths of innumerable sea birds — organized by the American government; in 1927 at London at the Conference for the Preservation of Aquatic Game Birds; and a year later at the Geneva Congress for International Bird Protection. At this last meeting, Holland, by special request, submitted a report

on the protection of wild birds and particularly of nesting grounds in that country.

Of great importance was the Seventh International Ornithological Congress held in Amsterdam in 1930. At that time, a number of resolutions setting forth the desirability of more effective measures of protecting the birds in all countries were passed. Similar action was taken by the Sixth International Botanical Congress in Amsterdam in 1935 for the international protection of wild flowers and plants.

tant part. What is now the fate of the wisents? We do not know; we fear it is the worst possible.

Consideration was also given another group of large mammals, the whales. Large-scale fishing, which had reached appalling dimensions, especially in the years before the war, had threatened to exterminate the whale. Several countries, among which were the Netherlands and the three Overseas Territories, accepted international regulations regarding whale fishing at the Convention of Geneva in 1931.

FIGURE 120. — *Varanus komodoensis* Ouwens IN KOMODO (Lesser Sunda Islands), AN EXTREMELY RARE AND INTERESTING LIZARD PROTECTED BY LAW. — After C. G. G. J. VAN STEENIS' "Album van Natuurmonumenten in Nederl.-Indië" (1937).

Birds and plants were not the only subjects of discussion; conferences about the protection of mammals were also organized.

First, we would like to draw attention to the efforts to preserve the almost extinct European buffalo, the wisent. In 1923, Holland, England, Germany, and some other nations founded the International Society for the Preservation of the Wisent. This was in Berlin. Their difficult task was to prevent the extinction of this extremely rare animal by judicious breeding. Centuries ago, the wisent roamed over most of Europe, including the Low Lands. Now there are only about sixty thorough-bred animals left. Even these are more or less domesticated. There are several of them in Germany; some are in the Zoo in Amsterdam; the rest are in the zoölogical gardens in Budapest, Stockholm, and London, and in private parks in England and Poland. The present war has terminated this laudable coöperation, in which Holland played an impor-

This enumeration of congresses, conferences, and so on may be monotonous for the reader, but it testifies to the ever-growing international realization that drastic measures must be taken if we are to check the increasing impoverishment of nature. It is clear that Holland has been giving active support to this movement.

* * *

Naturally, our country, with its important East and West Indian territories, is keenly interested in everything which concerns international protection of wild life in the tropics. Our share in the founding of the Standing Committee for the Protection of Nature in the Pacific — one of the results of the Fourth Pacific Science Congress in Bandoeng in 1929 — is proof of that interest.

Our interest in the African problems is, of course, less direct. However, the Netherlands and Netherlands Indies governments accepted a British invitation to send an observer to the Lon-

don International Conference for the protection of flora and fauna in Africa (1933) because analogous questions often arise in the East Indies and Africa. Article 17 of the Convention, adopted at that conference, makes it possible even for states without direct African interests to submit to the regulations of the treaty and to apply them in their own territories. After favorable advice from the East Indies' People's Council, the Netherlands government, on behalf of the Netherlands Indies, acceded to the Convention by the law of December 3, 1937. Among other things, this implies that the importation of game trophies from completely protected areas is prohibited.

In 1936, the British government took the initiative in calling a similar conference devoted to the interests of flora and fauna in Asia and Australia. Twelve countries, including Holland and the East Indies, were to participate. Because of the increasing political tension throughout the world, which eventually resulted in the outbreak of war in 1939, this meeting was never held. One can imagine how important a part the Indies, because of its geographical position between both continents, would have taken in these international discussions.

Let us look once again at Africa. Holland's interest in the natural life in that continent was shown not only in her submission to the Convention of London, but, more directly, by her participation in the administration of the Parc National Albert in the Belgian Congo. This large natural park, created in 1929, is the first reservation established internationally on national territory; therefore, it is exceptional. The general administration of the park is carried on by a council of twenty-four members, eight of whom must be foreigners of scientific authority and international renown as wild life conservationalists. For Holland, occupying an honorable seat beside the United States of America, England, France, and Sweden, Mr. P. G. VAN TIENHOVEN, indefatigable champion of the preservation of nature, previously mentioned more than once, was appointed. ALBERT, King of the Belgians, himself inaugurated this council with a speech in which he outlined the scientific significance of the natural park. The Netherlands government showed its interest by delegating the Netherlands minister to Belgium to the meeting.

Finally we want to call your attention to some Netherlanders in foreign countries who have done a great deal on behalf of the local nature protection. In Ceylon, a Netherlander is a member of the advisory council for the protection of flora and fauna on that island. In Africa, Netherlands' travellers have repeatedly drawn the attention of the local authorities to abuses of the protection of the big game animals. One was a warning of the late Mr. F. E. BLAAUW, former member of the Netherlands Committee, who in 1924 travelled through British East Africa. This noted lover of nature concluded his well-founded report on the menace of big game hunters to African fauna, by crying in distress, "When we see a fine picture, we admire it and don't put a knife through it. Why must all the beauties of nature, which are infinitely above what man can make, be destroyed by a few unscrupulous, unthinking fools, to the detriment of all those who truly admire them for their own sake?"

* * *

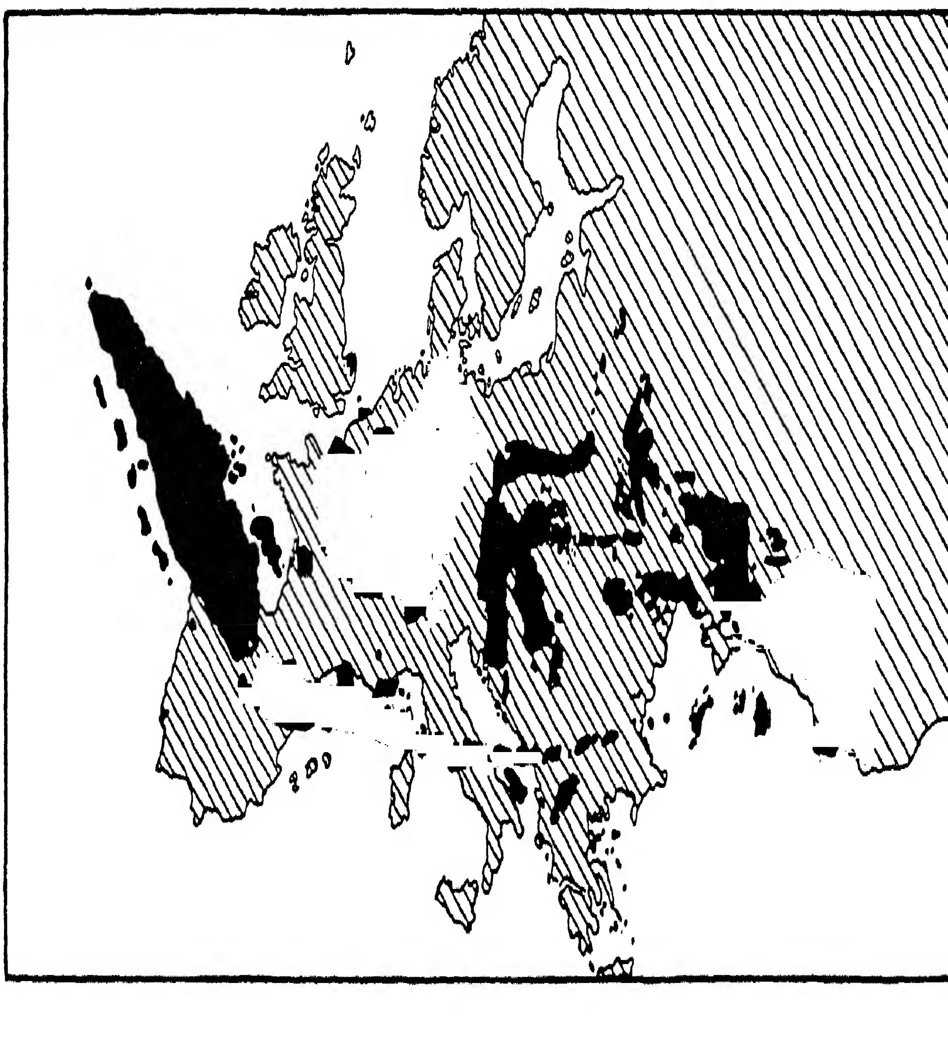
We have shown that both official and unofficial Netherlands have not failed to protect the rights of international wild life preservation, where and when necessary. Those who are further interested should consult an interesting booklet, written in 1931 by G. A. BROUWER, entitled *De organisatie van de natuurbescherming in de verschillende landen* (The organization of nature protection in various countries). So far as the writer of this article knows, this is the only publication in which the data on wild life conservation in most countries have been arranged in a surveyable manner. The importance of this Netherlands' compilation was recognized by the American Committee for International Wild Life Protection when they published an English translation in 1938. Certainly it would be commendable to print a revised, up-to-date edition of BROUWER's book.

### *Conclusion*

Cultivation proceeds rapidly in all parts of the world; the idea of protecting nature is also gaining; much has been achieved since BROUWER wrote his book in 1931. Likewise, there have been many setbacks. The destructive war which since September 1939 has harassed and disorganized the whole world is one of the most serious reverses.

After this world-struggle is over, may mankind face a happier future. May one of the fruits thereof be an energetic and purposeful striving after the preservation and esteem of Nature. No doubt, then as in the past, Netherlanders will be in the foremost ranks.

# SUPPLEMENTS



# SCIENTIFIC INSTITUTIONS, SOCIETIES AND RESEARCH WORKERS IN THE NETHERLANDS INDIES

*compiled by* FRANS VERDOORN, Ph.D. *and* J. G. VERDOORN, Phil. nat. dra.

*Editors of Chronica Botanica* [1]

The following lists[2] have been prepared at the request of the Government of the Netherlands Indies. They report about the government and private Netherlands Indies institutions, societies and research workers in pure ana applied science at the time of the Japanese invasion. Later changes, only rarely known to us, have as a rule not been included because the government and its advisers need primarily a list which will serve as a basis for various kinds of postwar planning. From the point of view of those engaged in work of this type, it is important to have a documentation, in one single place, of the scientific institutions, societies and research workers who were in the Netherlands Indies at the time of the invasion. We believe that this information will be useful also to scientists in the Netherlands and many other parts of the world, especially the United States and the British Empire. All who will use the following lists should, however, understand clearly that these lists do not, as a rule, report changes which occurred after the Japanese invasion.

Colleagues who held posts in the Netherlands Indies, but who were not there at the time of the invasion, have not been included. Most workers belonging to this category were in the Netherlands at the time of the German invasion of that country in May 1940. It was felt that it would complicate matters unduly to include these workers in a list reporting about the Netherlands Indies in 1942. A few high officials of considerable international standing who were abroad at the time of the invasion or who managed to escape in one way or another have been included; their names and their present addresses are given between brackets.

It has not been easy for us to compile the lists and we feel that they are not as complete and accurate as others of a similar nature which we prepared in the past. The information needed was difficult to obtain. We have gone through much literature, official and unofficial, and for a number of months we have had to trouble numerous correspondents all over the world, especially in Great Britain, the United States and Australia.

We have endeavoured to include all institutions and workers dealing with the subjects with which the present volume is concerned, *i.e.*, all branches of pure and applied science and technology. Our list of research workers for the biological and agricultural sciences will be fairly complete, in the field of technology and engineering it will be much less so. It must be understood that all workers included are not research workers in the strictest sense of the word. We have listed the same type of workers as are included *e.g.*, in the well-known "Lists of Research Workers in Agriculture and Forestry in the British Empire," though these and similar lists may contain names of somewhat more routine workers than does the present list. As in other lists of this kind, certain government officials have been automatically included, independent of whether they are engaged in research, organizing, or routine work.

We believe that the following lists will be useful for many purposes, but we warn all users once again that they have been prepared under wartime conditions and that it has often been impossible for us to obtain certain advice or literature. As a result the list may include a number of workers who have died before 1942, and other workers who were no longer employed in the Netherlands Indies at that time; in certain branches of science the names of some important workers will be missing.

It is impossible to mention all those who have helped us. In doing so we would make them partially responsible for the errors and omissions which may occur in these lists and for which, we feel, we alone are responsible. The interest and help of the numerous correspondents who assisted and advised us in the preparation of these lists and the reading of the proofs will always be gratefully remembered.

[1] Reprints of this list, interleaved with white paper, may be obtained by writing to the Library, Board for the Netherlands Indies, Surinam and Curaçao, 10 Rockefeller Plaza, New York 20, N.Y., *or* the Editor, Chronica Botanica Co., P. O. Box 151, Waltham 54, Mass.

[2] For an excellent previous enumeration see H. J. LAM's "Conspectus of Institutions of Pure and Applied Science in or concerning the Netherlands East Indies" (Science in the Netherlands East Indies, pp. 383–432, 1929). Also of interest are CH. J. BERNARD's "Scientific Institutes at Buitenzorg" (Fourth Pacific Science Congress, Java, 1929, Excursion B 1, 2) and the agricultural and botanical reports in Chronica Botanica 1 (1935), *seq.*

BALIK PAPAN (Borneo): —
Laboratories of the Shell Oil Co. (Bataafsche Petroleum Mij.).

BANDOENG (Java): —
Institute of Technology (Technische Hoogeschool).
Pasteur Institute (Instituut Pasteur en Landskoepokinrichting).
Laboratory for Forensic Chemistry (Scheikundig Laboratorium voor Forensische Onderzoekingen).
Cancer Institute (Laboratorium van het Nederl.-Indische Kankerinstituut).
Dept. of Mines (Dienst van den Mijnbouw): —
Geological Division
Div. of Geological Technology, etc.
Volcanological Service (Vulkanologische Dienst).
Seismological Service (Seismologische Dienst).
Div. of Radio Research of the Postal Administration (Afd. Radio-technisch Onderzoek der Post-, Telegraaf- en Telefoondienst).
Hydrodynamical Laboratory (Waterloopkundig Laboratorium).
Materials Testing Station (Lab. voor Materiaalonderzoek).
Ceramics Research Station (Keramisch Laboratorium).
Textile Research Station (Textielinrichting).
Lab. for Technical Hygiene (Lab. voor Technische Hygiëne).
Leprosy Research Institute (Instituut voor Lepra Onderzoek).

BATAVIA (Java): —
College of Medicine (Geneeskundige Hoogeschool).
Law School (Rechtshoogeschool).
Faculty of Arts and Philosophy (Faculteit der Letteren en Wijsbegeerte).
School of Public Administration (Bestuursacademie).
Nutrition Research Institute (Instituut voor Volksvoeding).
Eijkman Institute, Laboratories of the Public Health Service (Centraal Laboratorium van den Dienst der Volksgezondheid).
Laboratory for Aviation Physiology. — *Andir.*
R. Meteorological Observatory (Kon. Magnetisch en Meteorologisch Observatorium).
Topographical Survey (Topographische Dienst).
Fisheries Research Institute (Instituut voor de Zeevisscherij).
Laboratory for Marine Biology (Lab. voor het Onderzoek der Zee).
Central Technological Laboratories (Centraalbureau voor Technische Onderzoekingen).
Commercial Museum (Handelsmuseum).
Museum of the R. Batavian Society of Arts and Sciences (Museum van het Kon. Bataviaasch Genootschap van Kunsten en Wetenschappen).
Office of the Census (Centraal Kantoor voor de Statistiek).
Archaeological Service and Museum (Oudheidkundige Dienst en Museum).
Canning Laboratory (Conserven Laboratorium).
Government Archives ('s Lands Archief).

BOENOET (Kisaran, Sumatra O. K.): —
Plantation Research Dept. of the U.S. Rubber Plantations, Inc.

BRASTAGI (Sumatra O.K.): —
Batak Museum.

BUITENZORG (Java): —
College of Agriculture (Landbouwkundige Faculteit).
Govt. Botanic Gardens ('s Lands Plantentuin): —
Visitors' Laboratory (Treub Laboratorium).
Herbarium and Museum for Taxonomic Botany.
Zoological Museum and Laboratory.
Gen. Agricultural Experiment Station (Alg. Proefstation voor de Landbouw): —
Agricultural Institute (Landbouwkundig Instituut).
Botanical Laboratory (Plantkundig Laboratorium).
Div. of Experimental Gardens (Proeftuinen voor den Landbouw).
Phytopathological Institute (Instituut voor Plantenziekten).
Institute of Soils (Bodemkundig Instituut).
Institute for Agricultural Technology (Cultuurtechnisch Instituut).
Horticultural Division (Tuinbouwsectie).
Laboratory for Chemical Research (Chemisch Laboratorium): —
Div. for Agricultural Chemistry (Agricultuurchemische Afd.).
Phytochemical Div. (Phytochemische Afd.).
Analytical Div. (Analytische Afd.).

Neth. Indies Institute for Rubber Research (Nederl.-Indisch Instituut voor Rubber Onderzoek, NIRO).
Govt. Forest Research Institute (Boschbouwproefstation).
Experiment Station West Java (Proefstation West-Java).
Veterinary Research Institute (Veeartsenijkundig Instituut).
Veterinary College (Nederl.-Indische Veeartsenschool).
Laboratory for Inland Fisheries (Laboratorium voor de Binnenvisscherij).
Graduate School of Agriculture (Middelbare Landbouwschool).

DEN PASAR (Bali): —
Bali-Museum.

DJEMBER (Java): —
Besoeki Experiment Station.

DOLOK-MERANGIR (Sumatra O. K.): —
Plantation Research Dept. of the Goodyear Rubber Plantations Co., Inc.

FORT DE KOCK (Sumatra W. K.): —
Zoological Garden (Dierentuin).

GALANG (Sumatra O. K.): —
Research Branch of the "Rubber Cultuur Mij. Amsterdam."

JOGJAKARTA (Java): —
Batik Research Station (Consultatiebureau tevens Batikproefstation).
Tanning Experiment Station (Leerlooierij en Leerbewerkingsinrichting).
Museum Sånå Boedjåjå for Old and Modern Javanese and Balinese Art.

KLATEN (Java): —
Tobacco Experiment Station (Proefstation voor Vorstenlandsche Tabak).
Experiment Station of the "Klattensche Cultuurmij."

LEMBANG (Java): —
Astronomical Observatory (Bosscha Sterrenwacht)."

MADIOEN (Java): —
Graduate School of Forestry (Middelbare Boschbouwschool).

MAGELANG (Java): —
Magelang Museum.

MAKASSAR (Celebes): —
Regional Laboratory of the Public Health Service (Gewestelijk Laboratorium van den Dienst der Volksgezondheid).

MALANG (Java): —
Experiment Station Central and East Java at Malang (Proefstation Midden- en Oost-Java te Malang).
Planters School (Cultuurschool).

MEDAN (Sumatra O. K.): —
Tobacco Experiment Station (Deli-Proefstation).
Experiment Station of the Association of Sumatra Rubber Growers (Algemeen Proefstation der AVROS).
Pathological Laboratory (Pathologisch Laboratorium).

MENADO (Celebes): —
Institute for Agricultural Technology (Cultuurtechnisch Instituut).

MODJOKERTO (Java): —
Modjokerto Museum.

PALEMBANG (Sumatra): —
Palembang Museum.

PANGALAN BRANDAN (Sumatra O.K.): —
Laboratories of the Shell Oil Co. (Bataafsche Petroleum Mij.).

PAREE (Java): —
Experimental Gardens of the H.V.A. (Adviesdienst en Proeftuinen der "Handelsvereeniging Amsterdam").

PASAR MINGGOE (Java): —
Horticultural Experiment Gardens.

PASOEROEAN (Java): —
Java Sugar Experiment Station: —
Agricultural Dept.
Technological Dept.

PENGALENGAN, near Bandoeng (Java): —
Govt. Cinchona Experiment Station (Kinaproefstation).

PLADJOE PALEMBANG (Zuid-Sumatra): —
Laboratories of the Shell Oil Co. (Bataafsche Petroleum Mij.).

SEMARANG (Java): —
Experiment Station Central and East Java at Semarang (Proefstation Midden- en Oost-Java te Semarang).
Regional Laboratory of the Public Health Service (Gewestelijk Laboratorium van den Dienst der Volksgezondheid).

SIBOLANGIT (Sumatra O.K.): —
Botanic Gardens (Botanische Tuin).

SINGARADJA (Bali): —
Liefrinck-van der Tuuk Archives (Kirtya Liefrinck-van der Tuuk).

SOEBANG (Java): —
Research Dept. of the "Mij. tot Exploitatie van de Pamanoekan en Tjiasemlanden."

SOEKABOEMI (Java): —
Graduate School of Agriculture (Landbouwschool).

SOENGEI-GERONG (Zuid-Sumatra): —
Laboratories of the Nederl.-Indische Koloniale Petroleum Mij.

SOERABAJA (Java): —
College for Indonesian Physicians (Nederl.-Indische Artsenschool, NIAS).
School for Indonesian Dentists (School tot Opleiding van Indische Tandartsen).
Regional Laboratory of the Public Health Service (Gewestelijk Laboratorium van den Dienst der Volksgezondheid).
Laboratory of the Leprosy Research Institute.
Branch Laboratory of the Fisheries Research Institute (Afdeelingslab. van het Instituut voor de Zeevisscherij).
School for Technicians in Sugar Cane Factories and Plantations (Bondssuikerschool).
Museum.
Zoological and Botanic Gardens (Dieren- en Plantentuin).

SOERAKARTA (Java): —
Museum Sriwedari.

TERNATE (Moluccas): —
Museum Kedaton.

TJIBODAS (near Sindanglaija; Java): —
Biological Laboratory and Mountain Gardens of the Govt. Botanic Gardens.

TJIPETIR (Java): —
Laboratory for Gutta Percha (Gutta Percha Laboratorium).

Adriani-Kruyt Instituut. — *Menado.*

Adviescommissie voor Inheemsche Kruiden (Advisory Committee for Native Drug Plants). — *Batavia.*

Bond van Apothekers in Nederl.-Indië (Society of Neth. Indies Pharmacists). —*Batavia.*

Bond van Geneesheeren in Nederl.-Indië (Society of Neth. Indies Physicians). —*Soerabaja.*

Chineesche Landbouw Vereeniging in Nederl.-Indië (Chinese Agricultural Society). —*Batavia.*

Commissie van Advies inzake de bevordering van de cultuur van nieuwe handelsgewassen (Commission for the introduction of new economic plants). — *Batavia.*

Commissie te Batavia, welker taak is de Nederlandsche Pharmacopee-Commissie, gevestigd te Utrecht, by haar arbeid voor te lichten (Advisory Board of the Commission for the Netherlands Pharmacopoea). — *Batavia.*

Eugenetische Vereeniging (Society for Eugenetics). — *Batavia.*

Indisch Comité voor Wetenschappelijke Onderzoekingen (Committee for the Promotion of Scientific Research in the Neth. Indies). — *Batavia.*

Instituut voor Technische Hygiëne en Assaineering in Nederl.-Indië (Neth. Indies Institute for Technical Hygiene). — *Bandoeng.*

Java Instituut (Java Institute). — *Jogjakarta.*

Kirtya Liefrinck-van der Tuuk. — *Singaradja.*

Koningin Wilhelmina Instituut voor Lepra Onderzoek (Queen Wilhelmina Institute for Leprosy Research). — *Batavia.*

Kon. Bataviaasch Genootschap van Kunsten en Wetenschappen (R. Batavian Society of Arts and Sciences). — *Batavia.*

Kon. Instituut van Ingenieurs, Groep Nederl.-Indië (R. Institute of Engineers). — *Bandoeng.*

Kon. Nederlandsch Aardrijkskundig Genootschap, Afd. Nederl.-Indië (R. Neth. Geographical Society). — *Batavia C.*

Kon. Natuurkundige Vereeniging in Nederl.-Indië (R. Neth. Indies Science Society). — Koningsplein Zuid 11, *Batavia C.*

Landbouw-technische Vereeniging van Suikergeëmployeerden (Society of Technicians in Sugar Cane Plantations and Factories). — *Cheribon.*

Natuurwetenschappelijke Raad voor Nederl.-Indië (Neth. Indies Research Council). — Koningsplein Zuid 11, *Batavia C.*

Nederl.-Indische Apothekersvereeniging (Neth. Indies Pharmaceutical Society). — *Bandoeng.*

Nederl.-Indisch Bureau voor Anthropologie (Neth. Indies Bureau for Anthropology). — *Batavia.*

Nederl.-Indisch Instituut van Wageningsche Landbouwkundige Ingenieurs (Neth. Indies Institute of Wageningen Agricultural Engineers). — *Buitenzorg.*

Nederl.-Indisch Kankerinstituut (Neth. Indies Cancer Institute). — *Bandoeng.*

Nederl.-Indische Mij. tot Bevordering der Tandheelkunde (Neth. Indies Association for Dentistry). — *Batavia.*

Nederl.-Indische Natuurhistorische Vereeniging (Neth. Indies Natural History Society). — *Buitenzorg.*

Nederl.-Indische Sterrenkundige Vereeniging (Neth. Indies Astronomical Association). — *Bandoeng.*

Nederl.-Indische Vereeniging tot Bescherming van Dieren (Neth. Indies Society for the Protection of Animals). — *Batavia.*

Nederl.-Indische Vereeniging voor Diergeneeskunde (Neth. Indies Society for Veterinary Science). — *Semarang.*

Nederl.-Indische Vereeniging tot Natuurbescherming (Neth. Indies Society for Nature Protection). — 's Lands Plantentuin, *Buitenzorg.*

Oostkust van Sumatra-Instituut (Sumatra East Coast Society). — *Medan.*

Ornithologische Vereeniging in Nederl.-Indië (Neth. Indies Ornithological Society). — *Batavia.*

Raad voor de Normalisatie in Nederl.-Indië (Neth. Indies Council for Standardization). — *Bandoeng.*

Vereeniging tot Bevordering der Geneeskundige Wetenschappen in Nederl.-Indië (Neth. Indies Medical Society). — *Batavia.*

Vereeniging van Delftsche Ingenieurs (Alumni Association of the Delft Institute of Technology). — *Bandoeng.*

Vereeniging van Hoogere Ambtenaren bij het Boschwezen in Nederl.-Indië (Assoc. of Neth. Indies Foresters). — Boschbouwproefstation, *Buitenzorg.*

Vereeniging van Indonesische Geneeskundigen (Association of Indonesian Physicians). — *Batavia.*

Vereeniging van Landbouwconsulenten in Nederl.-Indië (Association of Agricultural Extension Officers in the Neth. Indies). — *Buitenzorg.*

Vereeniging van Mijningenieurs en Geologen bij den Dienst van den Mijnbouw in Nederlandsch-Indië (Association of Mining Engineers and Geologists of the Dept. of Mines). — *Bandoeng.*

Vereeniging Nederl.-Indisch Natuurwetenschappelijk Congres (Neth. Indies Science Congress). — Koningsplein Zuid 11, *Batavia C.*

Vereeniging van Proefstations Personeel (Society of Staff Members of Experiment Stations). — Proefstation West Java, *Buitenzorg.*

Vereeniging Venatoria (Society for the Promotion of Animal Sciences). — *Buitenzorg.*

Voedingsmiddelen Commissie (Commission for Food Research). — *Batavia.*

# ADDRESS LIST

**Aalfs** (Dr. **H. G.**) (1927, 1934)*, Govt. Veterinarian, Govt. Veterinary Service, *Bandoeng.*

**Abarbanel** (**J. M.**) (1928), Chief Govt. Physician, Library and Div. of Statistics, Govt. Medical Service, *Batavia.*

**Abdulrachman Saleh**, Assistant, College of Medicine, *Batavia.*

**Aboe Bakar** (Raden Mas), Physician, *Lewang.*

*These data show the year of appointment, *c.q.* reappointment of government officials. They are not given, however, for all government officials included in this list.

**Achmad Moechtar** (Dr.), Eijkman Institute, *Batavia.*

**Achterbergh** (Ir. **W. van**), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*

**Adam** (Dr. **J. W.**), Geologist, *Bandoeng.*

**Ahn** (Ir. **M.**) (1937), Forester, Govt. Forest Service.

**Akkersdijk** (Ir. **M. E.**), Extraord. Prof. of Mineralogy, Inst. of Technology, and Geologist, Dept. of Mines, *Bandoeng.*

**Alers** (**R.**) (1930, 1933), Extension Agronomist, *Malang.*

**Alewijn** (Jhr. **W. F.**), Technologist, Java Sugar Experiment Station, *Pasoeroean.*

**Alphen de Veer** (Ir. E. J. van) (1939), Forester, Govt. Forest Research Institute, *Buitenzorg*.
**Alphen** (Th. G. van) (1936), Inspector, Div. of Agriculture, Dept. of Economic Affairs, *Batavia*.
**Althuisius** (Ir. F. A.), Chemist, Experiment Station of the Assoc. of Sumatra Rubber Growers, *Medan*.
**Althuisius** (Ir. G.) (1939), Chemist, Govt. Opium Factory, *Batavia*.
**Altman** (G. J.), Supt., Sugar Factory Pandji, *Sitoebondo*.
**Altman** (Dr. R. F. A.), Chemist, N.I. Rubber Research Institute, *Buitenzorg*.
**Altmann** (H.), Agronomist, Java Sugar Expt. Station, *Pasoeroean*.
**Amerom** (Ir. W. F. H.) (1938), Chief Forester, Lawoe-Ponorogo Forests, *Madioen*.
**Amert** (C. C.), Agricultural Adviser, General Agricultural Syndicate, *Batavia*.
**Ameschot** (Ir. Th. A.), Mechanical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Ameyden van Duyn** (W. F. van), Forester, Ombilin Coal Mines, *Sawahloento*.
**Amons** (Prof. Ir. W. J. Th.) (1934, 1935, 1936), Director, Materials Testing Station, and Professor of Building Materials Research, Inst. of Technology, *Bandoeng*.
**Andriessen** (R.), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Ang Goan Hwat**, Assistant in Technical Hygiene, Inst. of Technology, *Bandoeng*.
**Angenent** (Dr. P. H.), Secretary, Office of the Census, *Batavia*.
**Angremond** (Dr. A. d'), Director and Botanist, Experiment Station of the Association of Sumatra Rubber Growers, *Medan*.
**Anthonijs Feher** (Ir. B. L.), Dept. of Roads and Waters, *Mataram* (Lombok).
**Appelman** (Ir. F. J.) (1928, 1935), Chief Forester, Malang Forests, *Malang*.
**Arends** (M. N.), Physician, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Arnaud Gerkens** (J. C. d'), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Arps** (W. C.), Physician, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Arragon** (G. W. van) (1928, 1938), Extension Ichthyologist (Fresh Water Fisheries), *Magelang*.
**Asbeck** (A. Baron van), Geologist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Asman** (M. C.), Expt. Station West Java, *Buitenzorg*.
**Assen** (Ir. A. M. van), Office of the Census, *Batavia*.
**Aulia**, Physician, *Batavia*.
**Awibowo** (Raden), Phytopathologist, Phytopathological Institute, Gen. Agricultural Experiment Station, *Buitenzorg*.

**Baak** (Ir. J. A.), Institute of Soils, General Agricultural Experiment Station, *Buitenzorg*.
**Baars** (Ir. C.) (1937), Assistant Forester, Bandoeng Forest District, *Bandoeng*.
**Baars** (Dr. J. K.) (1938), Technical Assistant, Eijkman Institute, *Batavia*, and extraord. Prof. Org. Chemistry, Institute of Technology, *Bandoeng*.
**Baartman** (Dr. A. Ph. G.), Physician and tempor. lecturer, Graduate School of Forestry, *Madioen*.
[**Baas-Becking** (Prof. Dr. L. G. M.), Director, Govt. Botanic Gardens, *Buitenzorg*. — Since 1940 in the Netherlands.]
**Badenhuizen** (Dr. N. P.), Assistant, Tobacco Experiment Station, *Klaten*.
**Badings** (Ir. L. S.), Chief Engineer, Electric Power Div., Dept. of Roads and Waters, *Bandoeng*.
**Bär** (Dr. Ir. A. L. S.), Agronomist, "Nederl. Handelsmij.", *Batavia*.
**Bahder Djohan**, Physician, *Batavia*.
**Bais** (Dr. W. J.), Physician, *Tebing Tinggi*.
**Bakhoven** (Ir. A. C.) (1928, 1934), Chief Forester, *Bandjermasin*.
**Bakhuizen van den Brink** (R. C.), Emeritus Botanist, and Hon. Collaborator, Herbarium, Govt. Botanic Gardens, *Buitenzorg*.
**Bakker** (P.) (1938), Lecturer of Agriculture, Planters School, *Malang*.
**Bakker** (Dr. S.) (1921, 1937), Director, Provincial Veterinary Service, *Batavia*.
**Bal** (A. J.) (1931, 1936), Agricultural Extension Agronomist, *Tandjongkarang* (Sumatra).
**Balk** (Ir. Th. P.) (1929, 1936), Chief Agricultural Extension Agronomist, *Kedoe* (C. Java).
**Bange** (J. A.) (1925, 1928, 1937), Extension Horticulturist, *Semarang*.
**Barbanson** (F. J. G. de) (1929, 1936), Extension Horticulturist, *Medan*.
**Barclay** (C.), Botanist, Plantation Research Dept., U. S. Rubber Plantations, Inc., *Boenoet*, Kisaran.
**Baren** (Dr. F. A. van), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Barentz** (Ir. P. H. I.), Office of the Census, *Batavia*.
**Barkey** (Ir. K. A.) (1929, 1937), Extension Agronomist, *Pontianak*.
**Bartels** (M.), Owner of private zoological museum, *Soekaboemi*.
**Bauer** (Mrs. L. S.) (1930), Div. of Agricultural Statistics, C. Statistical Office, *Batavia*.
**Bauwens** (J.) (1934), Chief Observator, R. Meteorological Observatory, *Batavia*.
**Bax Stevens** (Ir. O.), Assistant in Mechanics, Institute of Technology, *Bandoeng*.
**Beckering** (Ir. J. H.) (1938), Engineer, C. Purchasing Office, *Bandoeng*.
**Becking** (Dr. J. H.) (1936), Chief Inspector, Govt. Forest Service, *Buitenzorg*.
**Bedding** (Ir. W. Chr.), Director, Experiment Station of the Klattensche Cultuurmij., *Klaten*.
**Beek** (van), Phytopathological Institute, General Agricultural Experiment Station, *Buitenzorg*.
**Beens** (Ir. E. J.), Chief Engineer, Boekitasam Mines, *Tandjoeng-Enim*.
**Beernink** (L.), Assistant (Weights and Measures), Institute of Technology, *Bandoeng*.
**Beers** (Ir. W. F. J. van), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Beets** (Ir. C.) (1932, 1939), Chief Forester, Modjokerto Forest, *Modjokerto*.
**Beeuwkes** (H.), Bacteriologist, Eijkman Institute, *Batavia*.
**Begemann** (Ir. C. L.), Engineer, Electric Power Div., Dept. of Roads and Waters, *Bandoeng*.
**Behnke** (J. A.), Lecturer of Pharmacy, Medical College, *Batavia*.
**Belle** (Miss J. Th. L.) (1930, 1931), Assistant Curator, Herbarium, Govt. Botanic Gardens, *Buitenzorg*.
**Bemmel** (A. C. V. van) (1937), Ornithologist, Zoological Museum and Laboratory, Govt. Botanic Gardens, *Buitenzorg*.
**Bemmelen** (Dr. Ir. R. W. van), Chief, Vulcanological Survey, Dept. of Mines, *Bandoeng*.
**Benschop Koolhoven** (Ir. W. C.), Chief, Geological Div., Dept. of Mines, *Bandoeng*.
**Benthem** (J. van) (1934, 1935), Chief, Administration of the Govt. Forest Service, *Buitenzorg*.
**Berenschot** (Ir. G. H.), "Klattensche Cultuur Mij.", *Jokjakarta*.
**Berg** (Ir. A. van den), Chief Engineer, Div. of Harbours, Dept. of Roads and Waters, *Bandoeng*.
**Berg** (Ir. J. E. van den) (1936), Forester, Djatirogo Forest, *Djatirogo*.
**Bergen** (V. E. C. van) (1936), Inspector, Govt. Veterinary Service, *Batavia*.
**Bergh** (Ir. Th. P. van der), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Bergman** (Dr. R. A. M.) (1938), Lecturer in Anatomy, College for Native Physicians, *Soerabaja*.
**Berkel** (H. van), Secretary, Tobacco Experiment Station, *Medan*.
**Berkhout** (A. J. J.), Chief Technician, Institute of Technology, *Bandoeng*.
**Berlage** Jr. (Dr. H. P.) (1925), Research Associate, R. Meteorological Observatory, *Batavia*.
**Bernard** (Ir. A. N.) (1937), Forester, Poerwokerto Forests, *Poerwokerto*.
**Bernasco** (Ir. W.) (1938), Chief Forester, Blora Forest, *Blora*.
**Bernet Kempers** (Prof. Dr. A. J.), Archaeologist, *Batavia*.
**Bertram** (N. P. A.) (1938, 1939), Horticulturist, Horticultural Div., Gen. Agricultural Experiment Station, *Pasarminggoe*.
**Bes** (Ir. F. G.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Bestelink** (P. N.) (1923), Technician, R. Meteorological Observatory, *Batavia*.
**Betouw van der Voort** (Ir. J. in de), Mining Engineer, Divisional Head, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.

**Betrem** (Dr. J. G.), Entomologist, Experiment Station Central and East Java at Malang, *Malang*.
**Beukema** (W.), Physician, *Poeroek Tjahoe*.
**Beukering** (Ir. J. A. van) (1928, 1929, 1934), Extension Agronomist, *Batavia*.
**Beun** (Ir. M.), Java Sugar Experiment Station, *Pasoeroean*.
**Beusechem** (D. van), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Bianchi** (A. Th. J.) (1925, 1938), Chief Forester, and Head Technological Div., Govt. Forest Research Institute, *Buitenzorg*.
**Bie** (Ir. G. J. van der), Chemist, N.I. Rubber Research Institute, *Buitenzorg*.
**Bierdrager** (Dr. J.), Physician, Shell Oil Co. (B.P.M.), *Tarakan*.
**Bigot** (Ir. A.), Agricultural Mathematician, Java Sugar Expt. Station, *Pasoeroean*.
**Bijlaard** (Ir. P. P.), Professor of Civil Engineering (Roads and Bridges), Institute of Technology, *Bandoeng*.
**Bijleveld** (Ir. R.) (1935, 1938), Extension Agronomist, *Batavia*.
**Bijllaardt** (Ir. J. W. van den), Secretary, Visiting Board, Graduate School of Agriculture, *Buitenzorg*.
**Bijlsma** (Dr. U. G.), Temp. Professor of Pharmacology, College of Medicine, *Batavia*.
**Blank** (B. de), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Blanken** (Ir. P. L.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Bleichrodt** (Ir. F.) (1939), Chief Engineer, Govt. Medical Service, *Batavia*.
**Blekkingh** (Dr. J. J. A.), Research Chemist, Java Sugar Experiment Station, *Pasoeroean*.
**Bley** (Dr. G. F. J.), Member of the Council, R. Neth. Indies Science Society, *Batavia*.
**Blijdorp** (Ir. P. A.), Phytopathological Institute, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Blink** (Ir. G. C. van den) (1938), Forester and Silviculturist, Assistant to the Director, Govt. Forest Research Institute, *Buitenzorg*.
**Blits** (Mr. W. G.), Lecturer in Public Administration, Graduate School of Agriculture, *Buitenzorg*.
**Bloch** (Dr. A.) (1934), Lecturer, College for Indonesian Physicians, *Soerabaja*.
**Block** (J. L. K.), Assistant, Besoeki Experiment Station, *Djember*.
**Bloembergen** (Dr. S.), Assistant, Herbarium, Govt. Botanic Gardens, *Buitenzorg*.
**Blom** (Miss Dr. J.), Archaeological Service and Museum, *Batavia*.
**Blomberg** (Dr. C.) (1932, 1934), Inspector, Div. of Pharmacy, Govt. Medical Service, *Batavia*.
**Blommesteyn** (Miss H. H. A. van), Botanist, *Bandoeng*.
**Bobilioff** (Dr. W.), Formerly, Physiologist (rubber), AVROS, *Medan;* later, Physician on Sumatra.
**Bodegom** (Ir. A. H. van) (1938), Chief Forester, Randoeblatoeng Forest, *Randoeblatoeng*.
**Boedijn** (Prof. Dr. K. B.) (1928, 1936), Director, College of Agriculture, *Buitenzorg*.
**Boekenoogen** (J. G.), Divisional Head, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Boelman** (Dr. H. A. C.) Pharmacist, *Malang*, and Member, Advisory Committee for Native Drug Plants.
**Boer** (A. T. de), Sugar Factory Kanigoro, *Madioen*.
**Boer** (Dr. E. de) (1939), Bacteriologist, Veterinary Research Institute, *Buitenzorg*.
**Boer** (E. de) (1925, 1935), Lecturer of Architecture, Planters School, *Malang*.
**Boer** (Dr. H. J. de) (1938), Research Associate, R. Meteorological Observatory, *Batavia*.
**Boer** (J. H. de), Chemist, Experiment Station of the Klattensche Cultuurmij., *Klaten*.
**Boer** (R. de) (1929, 1939), Extension Ichthyologist (Fresh Water Fisheries), *Batavia*.
**Boerema** (Prof. Dr. J.) (1926), Director, R. Meteorological Observatory, and Professor of Physics, Medical College, *Batavia*.
**Boerjamin** (Raden), Leprosy Research Institute, *Bandoeng*.
**Boers** (Ir. F. H. J. A.), Extension Ichthyologist, *Buitenzorg*.
**Boesterd** (Ir. J. den), Engineer, Section "Bandoengsche Hoogvlakte," Electric Power Div., Dept. of Roads and Waters, *Bandoeng*.
**Boetzelaer** (Baron Mr. E. O. van), Lecturer in Public Administration, College of Agriculture, *Buitenzorg*.
**Bogtstra** (Ir. J. F.), Chemist, Java Sugar Expt. Station. *Pasoeroean*.
**Bokma** (Ir. F. T.), Chemist, Expt. Station West Java, *Buitenzorg*.
**Bokma** (H.), Physician, *Indramajoe*.
**Bolhuis** (Ir. G. G.), Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Bolle** (Dr. C. P.), Plant Pathologist, Java Sugar Experiment Station, *Pasoeroean*.
**Bolle** (Ir. J. A.), Mechanical Engineer, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Bon** (Ir. J.) (1939), Forester, Randoeblatoeng Forest, *Woeloeng*.
**Bonebakker** (Dr. A.), Physician, *Bandoeng*.
**Bonga** (B.) (1925, 1939), Govt. Veterinarian, Govt. Veterinary Service, *Soekaboemi*.
**Bonne** (Dr. C.), Professor of General and Criminal Medicine and Pathological Anatomy, Medical College, *Batavia*.
[**Bonne** (Dr. W. M.), at present Chief, Netherl. Medical Service, *Brisbane*.]
**Bonne-Wepster** (J.), Entomologist, *Batavia*.
**Boomgaart** (Drs. L.), Assistant for Geological Cartography, Dept. of Mines, *Bandoeng*.
**Boomstra** (Dr. W.), Professor of Mathematics, Institute of Technology, *Bandoeng*.
**Boon** (C.), Lecturer, Planters School, *Malang*.
**Boon van Ostade** (Dr. C. H.), Physician, *Semarang*.
**Boon** (Ir. D. A.) (1938), Chief Forester, Sumatra Forests, *Medan*.
**Boot** (C.) (1926), Chief Forester, Govt. Forest Service, *Buitenzorg*.
**Borden** (Ir. J. van der), Engineer, Div. of Geological Technology, Dept. of Mines, *Bandoeng*.
**Borst** (C. P.) (1932, 1936), Lecturer, College for Indonesian Physicians, *Soerabaja*.
**Borstlap** (A. J. P.), Physician, *Posso*.
**Bos** (Ir. J. H.) (1930, 1937), Chief Forester, Goenoeng Kidoel Forest, *Jogjakarta*.
**Bosch** (Dr. C. A. van den), Member of the Council, R. Neth. Indies Science Society, *Batavia*.
**Bosma** (M. J.), Physician, *Medan*.
**Both** (Dr. M. P.), Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Botke** (F.) (1930, 1938), Extension Ichthyologist (Fresh Water Fisheries), *Semarang*.
**Bottemanne** (C. J.) (1927, 1935, 1938), Head, Div. of Marine Fisheries, Dept. of Economic Affairs, *Batavia*.
**Bottenburg** (Ir. M. van) (1938, 1939), Chief Forester, Sumatra East Coast Forests, *Medan*.
**Bouma** (Drs. H.), Office of the Census, *Batavia*.
**Bouman** (R. J.), Geologist, % Head Office, Neth. Pacific Oil Co. (N.V. Nederl. Pacif. Petroleum Mij.), *Batavia*.
**Bouman** (W. E.) (1939), Lecturer, Veterinary College, *Buitenzorg*.
**Bout** (Ir. M. T. van den), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Bouwens** (Ir. A. L.), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Bouwman** (Ir. I. P. L.), Agronomist, Experiment Station Central and East Java at Semarang, *Semarang*.
**Braak** (Dr. H. R.), (1927), Adviser, Govt. Plantations, *Batavia*.
[**Braake** (Ir. A. L. ter), late General Manager, Banka Tin Mines, at present President and General Manager, Tin Processing Corporation, *Galveston*, Texas.]
**Braber** (Ir.), Laboratory for Chemical Research, *Buitenzorg*.
**Brand** (L. J. H.), Chief Technician, Medical College, *Batavia*.
**Brandt Corstius** (Miss T. C.), Eijkman Institute, *Batavia*.
**Bras** (G.), Assistant, Medical College, *Batavia*.
**Bresser** (E. H.) (1939), Div. of Wood Information and Publicity, Govt. Forest Research Institute, *Buitenzorg*.
**Brest van Kempen** (C. P.), Lieutenant Colonel, R. Neth. Indies Army, *Bandoeng* (Geophysics).
**Breuning** (Ir. H. A.), Chief Engineer (Govt. Buildings), Dept. of Roads and Waters, *Bandoeng*.
**Brink** (Dr. R.), Soil Expert, and Superintendent, Majanglanden, *Malang*.
**Brinkgreve** (Ir. J. H.) (1930, 1931), Extension Agronomist, *Palembang*.
**Brinkhorst** (J. G.), Supt., Sugar Factory Ngadiredjo, *Kras* SS/OL.

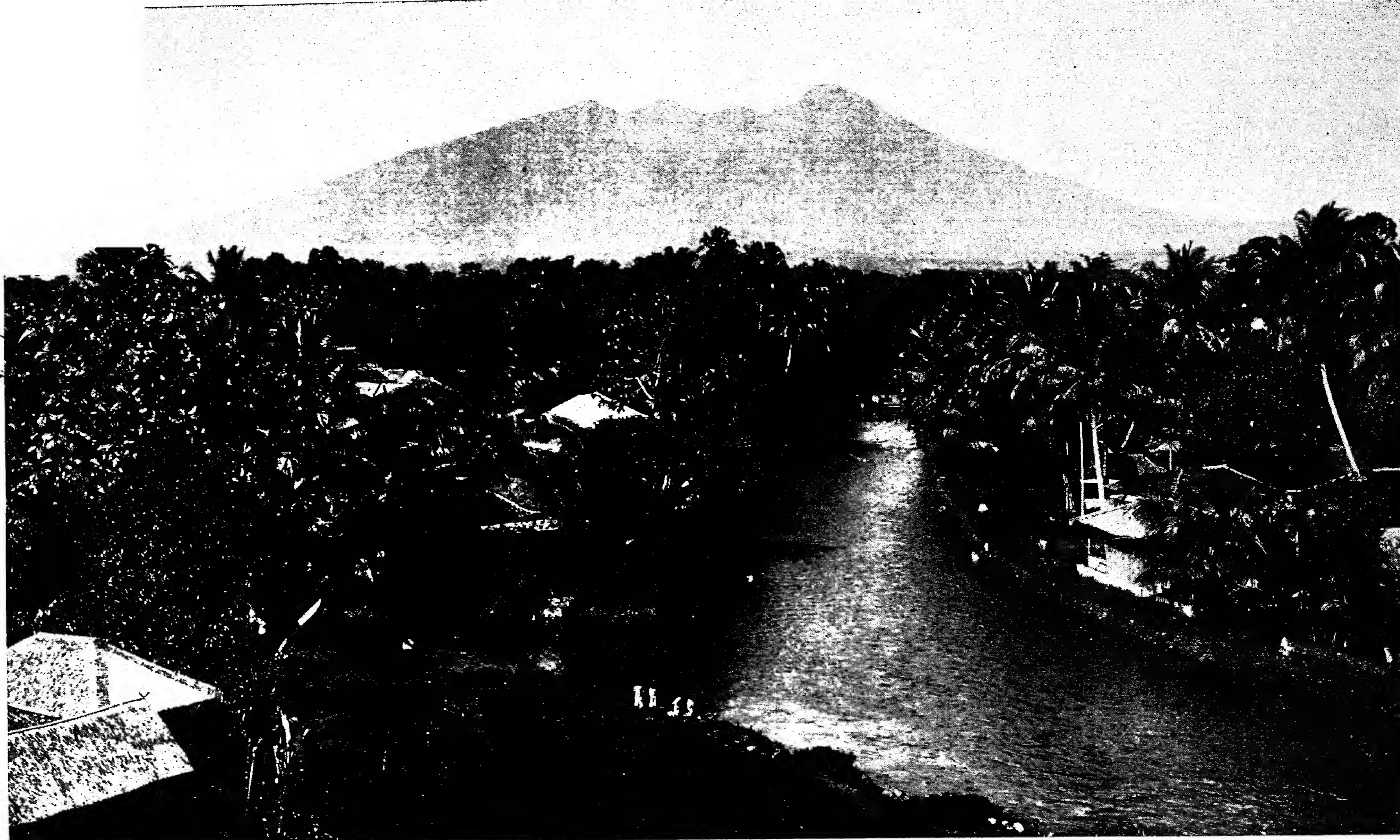


FIGURE 121. — THE SALAK SEEN FROM BUITENZORG, a lovely and famous view remembered and treasured by hundreds of scientific visitors, as well as thousands of tourists. — Photograph by E. E. WILSON ("Chinese Wilson") (1921), *courtesy Arnold Arboretum of Harvard University*.

**Brinks** (Ir. J. G.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Brocades Zaalberg** (Ir. J. W.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Brocx** (W. Ch. L.) (1925), Chief Forester, Govt. Forest Service, *Buitenzorg* (?).
**Broeke** (G. R. van den), Java Sugar Experiment Station, *Pasoeroean.*
**Broekhuizen** (Drs.), Technical and Scientific Section, Dept. of Economic Affairs, *Batavia.*
**Bronckhorst** (Ir. R. van) (1938), Director, Opium Factory, *Batavia.*
**Brons** (Dr. F.), Physicist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Brouwer** (Ir. A. R. H.), Chief Engineer (hydrodynamics), Dept. of Roads and Waters, *Bandoeng.*
**Brouwer** (L. E. J.), Geologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Brouwer** (Ir. P. J.) (1927, 1934), Chief Forester, Govt. Forest Service, *Buitenzorg.*
**Bruggeman** (M. L. A.) (1923, 1928, 1937), Acting Hortulanus, Govt. Botanic Gardens, *Buitenzorg.*
**Bruggen** (Dr. Ir. G. ter), Geologist, *Soengeiliat* (Banka).
**Bruggencate** (W. ten) (1930, 1934), Asst. Chemist, Laboratory for Chemical Research, *Buitenzorg.*
**Bruine** (Ir. T. J. P. de), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Bruyn** (Ir. E. E. de), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Bruyn Kops** (J. H. de), Head, Medical Service of C. Java, *Semarang.*
**Bruyn** (J. W. de), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Bruyn** (O. de) (1935), Lecturer, College for Indonesian Physicians, *Soerabaja.*
**Bryan** (Dr. J.), Physician, Standard Oil Co. (Ned.-Ind Kolon. Petr. Mij.), *Soengei-Gerong.*
**Buisman** (Ir. Y. D. B.) (1932, 1934), Lecturer in Science, Graduate School of Agriculture, *Buitenzorg.*
**Buitelaar** (Dr. L.), Physician, Hospital for Mental Diseases, *Lawang.*
**Buning** (W. L.), Paleontologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Burg** (Ir. A. H. J. L. van der), Engineer (Geol. Cartography), Dept. of Mines, *Bandoeng.*
**Burg** (Dr. J. H. N. van der) (1938), Lecturer, College for Indonesian Physicians, *Soerabaja.*
**Burger** (Dr. D.), Inspector, Govt. Forest Service, *Semarang.*
**Burger** (Dr. D. H.) (1939), Asst. Resident and temporary Collaborator, Dept. of Economic Affairs, *Batavia.*
**Burhoven Jaspers** (Ir. N. E.). — Civil (?) engineer, *Batavia* (also interested in orchids).
**Buschkiel** (Dr. A. C. F. L.) (1928, 1931, 1938), Extension Ichthyologist (Fresh Water Fisheries), *Batavia.*
**Buwalda** (Dr. P.), Botanist, Govt. Forest Research Institute, *Buitenzorg.*

**Caibin Indrajana** (1936), Lecturer, School for Indonesian Dentists, *Soerabaja.*
**Cake** (W. A.), Director, Plantation Research Dept. of the U. S. Rubber Plantations, Inc., *Boenoet*, Kisaran.
**Camproni** (Ir. E. Ch.), Chemist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*
**Canter-Visscher** (T. C. E. W.) (1934), Director, Graduate School of Agriculture, *Buitenzorg.*
**Carrière** (Ir. J. D.), Engineer, Electric Power Div., Dept. of Roads and Waters, *Bandoeng.*
**Charlouis** (M. Th.), Agronomist, Sugar Factory, *Pesantren.*
**Chasan Boesoirie**, Physician, *Weda.*
**Choufour** (J. C.) (1929, 1936), Chief, Soerabaja District, Provincial Veterinary Service, *Soerabaja.*
**Clason** (Ir. E. W. H.), Agricultural Dept., Java Sugar Experiment Station, *Pasoeroean.*
**Claus** (Ir. G.), Chemist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*
**Clobus** (A. G. J.), Sugar Factory Kanigoro, *Madioen.*
**Coenen** (Ir. J. W.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Coert** (Dr. J. H.), Agricultural Adviser, Tiedeman & van Kerchem Cy., *Soerabaja.*
**Cohen Stuart** (Mr. J. W. T. R.), Office of the Census, *Batavia.*
**Cohen** (Ir. L.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Cohen** (Drs. H.) (1939), Economist, Dept. of Economic Affairs, *Batavia*
**Collet** (A. M.), Assistant, Medical College, *Batavia.*
**Collier** (Dr. W. A.) (1937), Scientific Assistant, Eijkman Institute, *Batavia.*
**Colthoff** (Ir. J. P. J.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Colyn** (Dr. A. H.), Divisional Head, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Cooke** (Ir. L. F.), Assistant (Civil Engineering), Institute of Technology, *Bandoeng.*
**Coolhaas** (Dr. Ir. C.), Director, Experiment Station Central and East Java at Malang, *Malang.*
**Coreelmont** (L. Ch. A.) (1939), Assistant, R. Meteorological Observatory, *Batavia.*
**Cortenbach** (Ir. W. J. K.) (1936), Forester (Sumatra East Coast), *Medan* (?).
**Corts** (A. H. A.) (1925, 1929, 1939), Extension Agronomist for C. Java.
**Coster** (Dr. Ir. Ch.) (1926, 1936), Director, Experiment Station West-Java, *Buitenzorg.*
**Coultre** (Dr. A. P. le) (1922, 1936), Chief, Provincial Veterinary Service, *Soerabaja.*
**Couvret** (Ir. F.) (1941), Marine Engineer, Navy Yard, *Soerabaja.*
**Couwenberg** (J. F.), Agronomist, Expt. Station West Java, *Buitenzorg.*
**Couwenberg** (Miss M.), Assistant for Technical Hygiene, Institute of Technology, *Bandoeng.*
**Cramer** (Dr. P. J.), late Director, Gen. Agricultural Expt. Station; Teacher, Graduate School for Agriculture, *Buitenzorg.*
**Creutzberg** (Mr. P.) (1936, 1939), Div. of Coöperation and Domestic Trade, Dept. of Economic Affairs, *Batavia.*
**Creutzberg** (W. A. G.) (1933, 1935), Advisor, Dept. of Economic Affairs, *Batavia.*
**Crince le Roy** (A. A.), Head, Provincial Agricultural Extension Service, *Soerabaja.*
**Crince le Roy** (X. F.), Head, Provincial Agricultural Extension Service, *Batavia.*
**Croll** (Ir. D.), Chemist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*
**Cronshey** (J. F. H.), Phytopathologist, Plantation Research Dept., U. S. Rubber Plantations, Inc., *Boenoet*, Kisaran.
**Crucq** (Dr. K. C.), Archaeological Service and Museum, *Batavia.*

**Daamen** (C. B. F.), First Assistant, Medical College, *Batavia.*
**Dajat Hidajat** (Mas) (1939), Lecturer in Medicine, School for Indonesian Physicians, *Soerabaja.*
**Dakkus** (P. M. W.) (1921, 1927, 1937), Hortulanus, Govt. Botanic Gardens, *Buitenzorg*, and Captain, Royal Neth. Air Force, *Bandoeng.*
**Dalfsen** (Ir. J. W. van), Chemist (rubber), Neth. Indies Rubber Research Institute, *Buitenzorg.*
**Dam** (Dr. L. van) (1939), Oceanographer, Laboratory for Marine Biology, *Batavia.*
**Dames** (Ir. T. W. G.), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Danhof** (Ir. G. N.) (1938), Chief Forester, Lampong Districts Forests, *Tandjong-karang.*
**Darmawan Mangoenkoesoemo** (Ir.) (1926, 1928), Head, Information Office of the Section of Small Industries, Dept. of Economic Affairs, *Soerabaja.*
**Darwis** (A.), Physician, *Solok.*
**Davidis** (Ir. G. H. F.) (1939), Extension Agronomist (Province of West Java), *Buitenzorg* (?).
**Davis** (Ir. F. H. J.) (1933, 1938), Head, Information Office for the Outer Districts, Dept. of Economic Affairs, *Batavia.*
**Dedem** (Ir. G. W. Baron van), Mining Engineer, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*
**Deinema** (Ir. J.), Technological Adviser, "Cultuurmij. der Vorstenlanden," *Semarang.*
**Dekker** (Ir. J. F.) (1938), Extension Agronomist (Govt. East Java).
**Denekamp** (J.) (1939), Temporary Director, Office of Weights and Measures, *Bandoeng.*
**Deutman** (Dr. A. A. F. M.), Physician, *Soerabaja.*
**Deys** (Dr. W. B.), Chemist, N.I. Rubber Research Institute, *Buitenzorg.*
**Diakonoff** (Dr. A.), Entomologist, Java Sugar Expt. Station, *Pasoeroean.*
**Dieben** (Dr. C. P. A.) (1932, 1933, 1938), Inspector, Govt. Veterinary Service, *Soerabaja.*

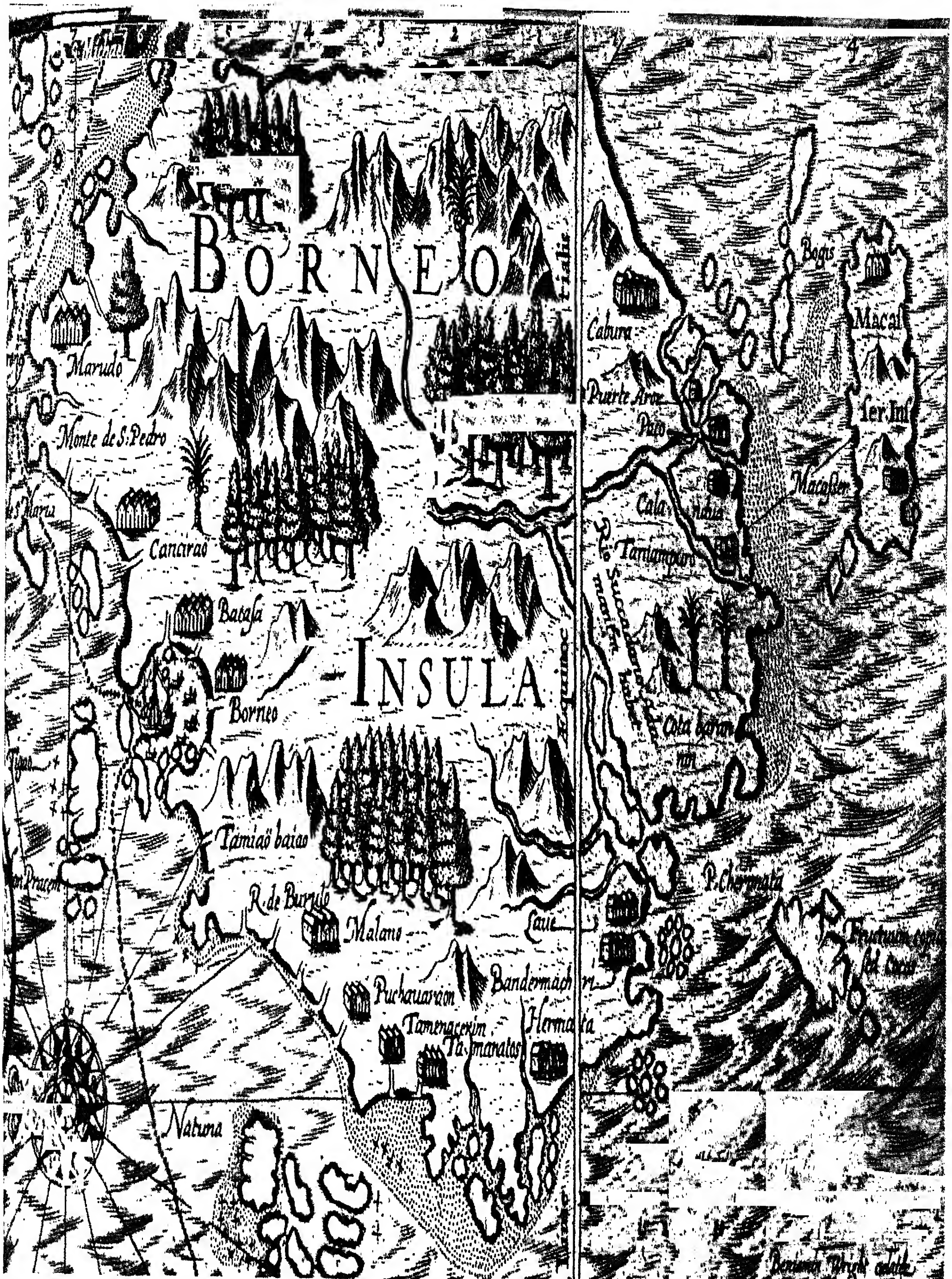



FIGURE 122. — EARLY MAP OF BORNEO, from "Beschrijvinge van de Schipvaerd by de Hollanders ghedaen onder 't beleydt ende Generaelschap van OLIVIER VAN NOORT, door de Straet ofte Engte van Magallanes, ende voorts de gantsche Kloot des Aertbodems om" *in* "Begin ende Voortgangh van de Vereenighde Nederlantsche Geoctroyeerde Oost-Indische Compagnie" (1646). — *Courtesy Arnold Arboretum of Harvard University.*

**Dieperink** (B. E.), Geologist, % Head Office, Neth. Pacific Oil Co. (N.V. Nederl. Pacif. Petroleum Mij.), *Batavia*.
**Dijk** (Ir. J. van), Head, Agricultural Dept., Java Sugar Expt. Station, *Pasoeroean*.
**Dijk** (Ir. J. W. van), Lecturer in Agriculture, Institute of Technology, *Bandoeng*.
**Dijk** (Ir. L. J. van) (1934), Forester, Govt. Forest Service, *Buitenzorg*.
**Dijkman** (Dr. M. J.), Extension Agronomist, *Tandjongkarang*.
**Dijkmans** (Ir. M. A. F.) (1927, 1937), Chief Forester, Govt. Forest Service, *Buitenzorg*.
**Dijksterhuis** (Dr. T.), Member of the Council, Section Bandoeng, R. Neth. Indies Science Society, *Bandoeng*.
**Dijkstra** (Ir. A.) (1926, 1933), Extension Agronomist (Prov. Central Java), *Jogjakarta*.
**Dillen** (Ir. L. R. van), Chemist, Experiment Station of the Association of Sumatra Rubber Growers, *Medan*.
**Dinger** (Dr. J. E.), Professor of Hygiene, Bacteriology and Serology, Medical College, *Batavia*.
[**Dissel** (Ir. G. L. van), at present with Netherlands Purchasing Commission, *New York City*.]
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**Doeglas** (Dr. A.) (1927, 1935), Chief Govt. Veterinarian, Govt. Veterinary Service, *Padang*.
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**Dohmen** (J. H.) (1930), Keeper, Archives of the Govt. Forest Service, *Buitenzorg*.
**Donicie** (Ir. P. J.) (1939), Extension Agronomist, *Bandjermasin*.
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**Doorn** (Ir. P. van) (1938), Extension Agronomist, *Menado*.
**Doorn** (Z. van) (1936, 1938), Chief Forester, Govt. Forest Service, *Buitenzorg*.
**Dort** (Ir. Th. K. L. van), Manager, Sugar Factory Tjandi, *Sidoardjo*.
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**Duin** (Ir. J. van), temporary Assistant, Java Sugar Experiment Station, *Pasoeroean*.
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**Dumas** (F. A.) (1929, 1930), Assistant, Div. of Agricultural Statistics, C. Statistical Office, *Batavia*.
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**Duyvendijk** (Ir. J. A.), Phytopathological Institute, Gen. Agricultural Experiment Station, *Buitenzorg*.

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**Elemans** (G. F.) (1938), Extension Horticulturist (Prov. C. Java).
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**Essenburg** (Ir. J. F. W.) (1938), Chief Forester, Govt. Forest Service, *Jogjakarta*.
**Esser** (Ir. F.) (1930, 1936), Chief Forester, Kendal Forest, *Semarang*.
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**Fanoy** (J. A. H.), Sugar Factory Soedhono.
[**Farrow** (Dr. M. D.), at present Head of Economic Reconstruction Section, Netherlands Indies Government, *Brisbane*.]

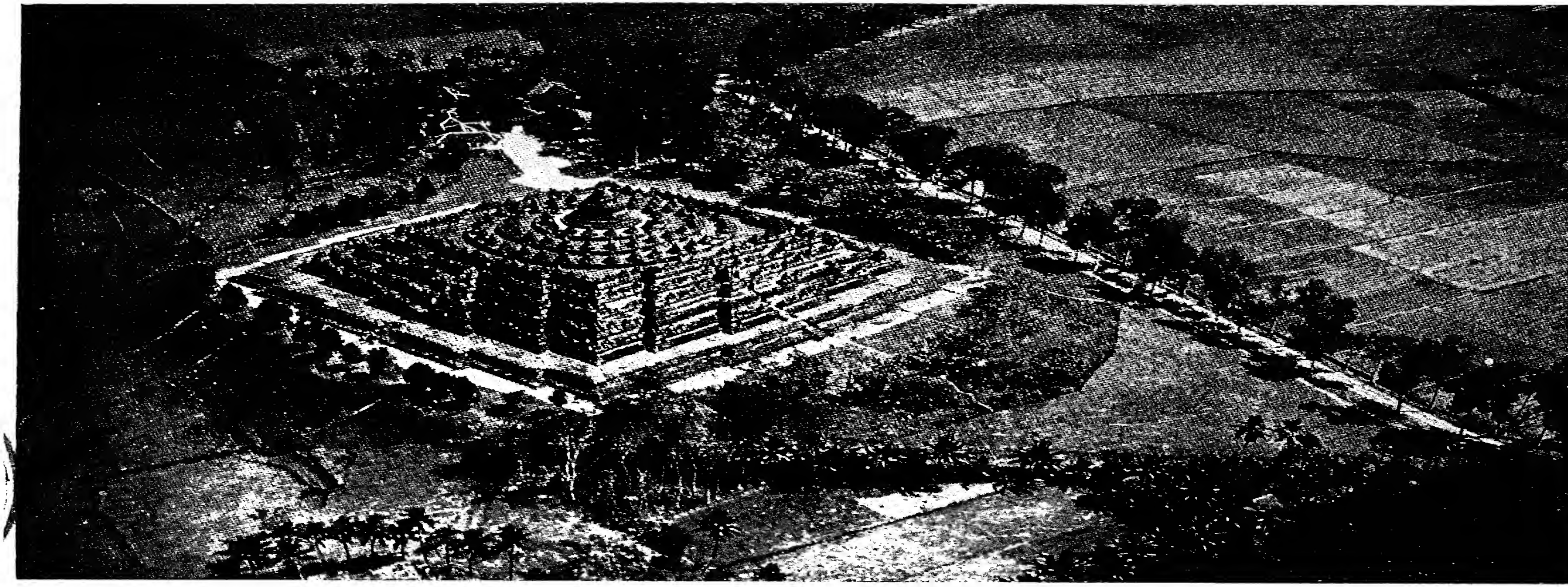

FIGURE 123. — AERIAL VIEW OF THE BOROBUDUR, CENTRAL JAVA, showing the lower, many-cornered terraces, the three circular terraces above them, and the stūpa at the top. The monument, erected between 750 and 850 A.D., is a symbol of the Mahāyāna Buddhist doctrine of the world, of life and of salvation. The many-cornered terraces are richly ornamented and contain long rows of reliefs illustrating Buddhist texts dealing with the effects of karma (good and bad deeds), with the life of the Buddha, with stories of the Buddha's former births (Jātakas), and with various other Buddhist legends. The circular terraces are completely plain, save for bell-shaped stūpas of lattice work, each containing the image of a Dhyānī Buddha (celestial Buddha). They represent the highest heavens, inhabited by pure spiritual beings.

**Faure** (Ir. H. E. J. J.) (1938), Extension Agronomist, *Makassar.*

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**Ferzenaar** (H. J. G.), Assistant (materials testing), Institute of Technology, *Bandoeng.*

**Fischer** (Dr. I. A.), Inspector, Govt. Medical Service, *Batavia.*

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**Fluyt** (Ir. P. C. M.) (1938), Chief Forester, Djember Forests, *Djember.*

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**Freeve** (Ir. J.) (1937), Forester, Ombilin Mines, *Sawahloento.*

**Freusberg** (Ir. A. F. W.), Chief, Technical Div., Dept. of Mines, *Bandoeng.*

**Frijd** (A. A.) (1925, 1935), Forester, Madioen Forest, *Ponorogo.*

**Gabel** (J. L.), Phytopathologist, Besoeki Experiment Station, *Djember*, Java.

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**Gandrup** (J.), late Director, Expt. Station C. and E. Java, *Malang.*

**Gaster** (Ir. A. A. H.), Chief, Technical Div., Air Raid Protection, *Bandoeng.*

**Gatot** (R. Kd.), formerly, Chief Forester, Govt. Forest Service, *Koeningan.*

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**Gerlings** (Ir. C.), Extension Agronomist (Prov. Central Java), *Pati.*

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**Giesen** (Dr. J. Th.), Physician, *Batavia-C.*

**Giessen** (Ir. C. van der), Head, Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg.*

**Gils** (Dr. G. E. van), Chemist (Rubber), Neth. Indies Rubber Research Institute, *Buitenzorg.*

**Gisolf** (Dr. Ir. W. F.), Petrologist, *Bandoeng.*

**Gispen** (Dr. R.), Assistant, Medical College, *Batavia.*

**Glasbergen** (G.), Sugar Plantation Nieuw-Tersana, *Cheribon.*

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**Göbert** (F. E.) (1937), Chief Technician, College for Indonesian Physicians, *Soerabaja.*

**Goenoeng Iskandar** (Ir. Raden), Extension Agronomist for the Lampong Districts, *Tandjongkarang.*

**Götz van der Vet** (J. C. L.) (1935, 1937), Chief Extension Agronomist (Soerakarta & Jogjakarta), *Jogjakarta.*

**Gogh** (Ir. F. van) (1927, 1935), Extension Agronomist, *Batavia.*

**Goldman** (W.), Technician, Graduate School of Agriculture, *Buitenzorg.*

**Gomperts** (Dr. C. E.), Physician, *Koetaradja.*

**Gonggrijp** (Ir. H.), Agronomist, Experiment Station of the Association of Sumatra Rubber Growers, *Medan.*

**Gonggrijp** (Ir. L.) (1928, 1936), Chief Forester, and Head, Div. of Hydrology, Govt. Forest Research Institute, *Buitenzorg.*

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**Goossens** (H. J.) (1931, 1932), Extension Ichthyologist (Fresh Water Fisheries), *Buitenzorg.*

**Goot** (Dr. P. van der), Head, Phytopathological Institute, Gen. Agricultural Experiment Station, *Buitenzorg.*

**Gothein** (Dr. W. G. K.), Chief Govt. Physician (Prov. Buitenzorg), *Buitenzorg.*

**Goudswaard** (Colonel Adr.), Chief Pharmacist, Military Medical Service, *Bandoeng.*

**Goudswaard** (Arie), Director, Chemical Laboratory, War Dept., *Bandoeng.*

**Gouka** (Ir. C.) (1937), Forester, Govt. Forest Research Institute, *Buitenzorg.*

**Gout** (Miss E.) (1939), Lecturer, School for Indonesian Dentists, *Soerabaja.*

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**Graaff** (Ir. D. de), Coffee Plantation, *Soekamangli.*

**Graaff** (Mr. W. de) (1938, 1939), Editor of Publications, Dept. of Economic Affairs, *Batavia.*

**Gramberg** (Ir. J.), Engineer (Tin Processing), Banka Tin Mines, *Banka.*

**Grandjean** (Ir. G. B.), Volcanologist, *Jogjakarta.*

**Gratama** (Ir. B. J.), Sugar Factory Somobito.

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**Griffioen** (Dr. K.), Plant Physiologist, *Buitenzorg.*

**Grijp** (A. de) (1925, 1938), Forester, *Menado.*

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**Groot** (Ir. J. E. de) (1939), Chemist, Laboratory for Chemical Research, *Buitenzorg.*

Figure 124. — Two Reliefs from the First Gallery of the Borobudur. — *Above:* A scene from the legend of the Buddha. After having ended his period of asceticism and before setting out to Bodhimanda, where he will achieve final enlightenment and become the Buddha, the Bodhisatva (future Buddha) takes a bath in the river Nairanjanā. The gods adore him and shower him with celestial flowers. — *Below:* A scene from the story of Rudrāyana. King Rudrāyana of Roruka, having been converted to Buddhism, has abdicated in order to become a monk. His son reigns as a tyrant, dismisses his father's faithful ministers, persecutes religion, and in the end murders his own father. In retribution for his sins, Roruka is annihilated by a sand-storm. Warned of the impending disaster, Rudrāyana's virtuous former ministers escape in time. The relief shows two distinct scenes: on the right, the ship carrying Hiru, one of the ministers; on the left, Hiru's landing on a distant shore where he will found the city of Hiruka.

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**Groot** (Ir. **P. J. de**), Mechanical Engineer, Refineries, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Grootings** (**J. W.**), Govt. Physician (Tasikmalaja & Tjiamis), *Tasikmalaja*.
**Gruyter** (Ir. **P. de**), Chief of Research, Govt. Railroads, *Bandoeng*.

**Haan** (Dr. **Iz. de**), Botanist, Experiment Station West Java, *Buitenzorg*.
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**Haanappel** (**H. E.**), Sugar Factory Semboro, *Tanggoel*.
**Haart** (Ir. **P. de**), "Parapattan" Coal Mines, Eastern Borneo.
**Haas** (**C. P. J. de**), Zoologist, Tea Plantation near *Tasikmalaja*.
**Haas** (Dr. **J. H. de**), Lecturer Pediatrics, Medical College, *Batavia*.
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**Hadiwidjaja**, Phytopathological Institute, General Agricultural Experiment Station, *Buitenzorg*.
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**Haeften** (Ir. **Ch. F. van**), Director, Dept. of Roads and Waters, *Bandoeng*.
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**Harreveld** (**J. van**), late Secretary, Java Sugar Expt. Station; Lawyer, *Batavia*.
**Harreveld** (Dr. **Ph. van**), late Director, Java Sugar Expt. Station; *Pengalengan near Bandoeng*
**Harst** (Ir. **G. van der**), Head, Electric Power Div., Dept. of Roads and Waters, *Bandoeng*.
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**Hasselt** (Ir. **B. Th. W. van**), Engineer, Div. of Harbours, Dept. of Roads and Waters, *Bandoeng*.
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**Heinsdijk** (Ir. **D.**) (1936), Forester, Govt. Forest Service, *Soerabaja*.
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**Hekster** (Ir. **S.**), Chief, Div. of Transmission, Div. of Radio Research of the Postal Administration, *Bandoeng*.
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**Hens** (Mr. **A. P. G.**) (1939), President, General Accounting Office, *Batavia*.
**Her** (**E. J.**), Assistant, Besoeki Experiment Station, *Djember*.
**Herber** (**N.**), Technician, Medical College, *Batavia*.
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**Heubel** (Ir. **G. A.**), Agricultural Adviser, "Internatio" Trading Co.; formerly, with Experiment Station Central and East Java, *Semarang*.
**Heurn** (Jhr. **W. C. van**) (1933), Lecturer, College for Indonesian Physicians, *Soerabaja*.
**Heusden** (**W. C. van**), Agriculturist, General Agricultural Syndicate, *Batavia*.
**Heyden** (**W. F. L. van der**) (1931), Extension Ichthyologist, *Salatiga*.
**Heyn** (Dr. **A. N. J.**) (1936, 1939), Adviser, Batik Research Station, and Extension Officer, Dept. of Economic Affairs, *Jogjakarta*.
**Hildebrand** (**F. H.**), Forester, Govt. Forest Research Institute, *Buitenzorg*.
**Hilgers** (**C.**), Senior Geologist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Hille Ris Lambers** (Dr. **M.**), Geneticist, Experiment Station Central and East Java at Malang, *Malang*.
**Hillen** (Ir. **C.**), Director, Postal Administration, *Bandoeng*.
**Hirsch** (Dr. **H. Th.**), Extension Agronomist (Prov. Eastern Java).
**Hissink** (Ir. **J. J.**), Inspector, Div. of Roads, Dept. of Roads and Waters, *Bandoeng*.
**Hoedt** (**G. H. A.**) (1921, 1934), Head, Dactyloscopic Laboratory, Dept. of Justice, *Batavia*.
**Hoedt** (Dr. Ir. **Th. G. E.**), late Director, Experiment Station West Java, *Buitenzorg*.
**Hoeing** (**A.**) (1931, 1936), Extension Horticulturist, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Hoek** (Ir. **A. van**), Chief Engineer (Tin Processing), Banka Tin Mines, *Banka*.
**Hoek** (Ir. **M.**) (1937), Forester, Bantam Forests, *Serang*.
**Hoek Spaans** (**C.**) (1938), Lecturer, Veterinary College, *Buitenzorg*.
**Hoeks** (**B. M.**) (1938), Lecturer on Fisheries, Graduate School of Agriculture, Buitenzorg and Chief Ichthy-

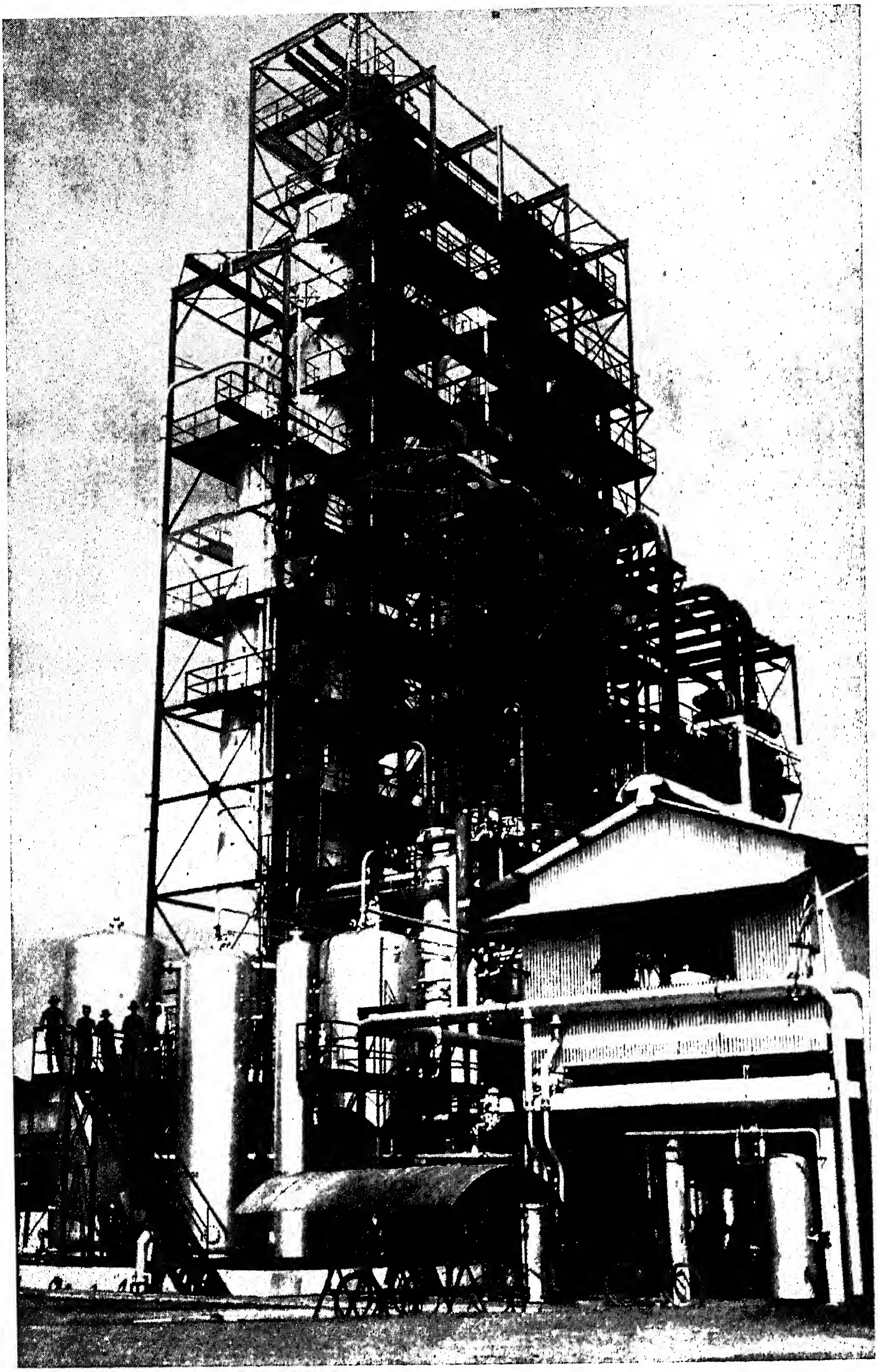

FIGURE 125. — ONE OF THE OIL REFINERIES IN PALEMBANG (Sumatra). — This refinery was destroyed at the outbreak of the war. — *Courtesy Netherlands Information Bureau, New York City.*

ologist, Extension Div., Div. of Agriculture, Dept. of Economic Affairs, *Buitenzorg*.
**Hoekstra** (Ir. J. A.), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Hoekstra** (P.) (1936), Chief Govt. Veterinarian, Govt. Veterinary Service, *Batavia*.
**Hoesein Djajadiningrat** (Pangeran Prof. Dr. Ario), formerly, Professor, Law School, and Member, Council for the Neth. Indies, *Batavia*.
**Hoetjer** (Mr. Ir. J. F. N.), Engineer, Section of Irrigation, Div. of Waters, Dept. of Roads and Waters, *Bandoeng*.
**Hofman** (Ir. G. H. B.) (1934, 1938), Silviculturist, Govt. Forestry Service, *Buitenzorg* (?).
**Hofstede** (Ir. A. E.) (1938), Extension Agronomist (Prov. West Java), *Batavia* (?).
**Hofstee** (J.) (1929, 1936), Extension Ichthyologist, *Pamekasan*.
**Hofsteenge** (Dr. G. L.), Geologist, % Head Office, Neth. Pacific Oil Co. (N. V. Nederl. Pacif. Petroleum Mij.), *Batavia*.
**Hogezand** (Major H. E. van), Topographical Survey, *Weltevreden*.
**Holin** (L.) (1939), Extension Horticulturist, *Jogjakarta*.
**Hollander** (Dr. F. C.), Surgeon, Medical Dept., Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Holle** (Ir. J. A. C.) (1937, 1939), Extension Agronomist, *Palembang*.
**Holleman** (Dr. L. W. J.) (1939), Chemist, Laboratory for Chemical Research, *Buitenzorg*.
**Holleman** (Ir. W.), Chief, Dept. of Mines, *Bandoeng*.
**Hollerwöger** (F.) (1928, 1939), Govt. Forest Service, *Buitenzorg*.
**Holterman ten Hove** (M. W.) (1925, 1937), Chief Forester, *Kedoe Forests*.
**Homans** (Miss Ir. L. N. S.), Chemist (Rubber), Neth. Indies Rubber Research Institute, *Buitenzorg*.
**Honert** (Dr. T. H. van den) (1937), Temporary Director, Govt. Botanic Gardens, *Buitenzorg*.
[**Honig** (Dr. P.), late Director of the Experiment Station of the Java Sugar Industry and the Rubber Research Institute, President Intern. Association of Sugar Cane Technologists, at present Member, Board for the Netherlands Indies, Surinam and Curaçao, *New York City*.]
**Hoogendam** (J.), Physician, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Hoogerwerf** (A.) (1937, 1938), Assistant to the Director, Govt. Botanic Gardens, *Buitenzorg*.
**Hoogstraaten** (Ir. R. van), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Hoop** (Dr. A. N. J. Thomassen à Thuessink van der), Conservator, Prehistoric and Ethnographic Collections, Kon. Bataviaasch Genootschap van K. en W., *Batavia*.
**Hoorn** (J.), Technician, Planters School, *Malang*.
**Horst** (E. C. J. van der), Supt., Sugar Plantation Djatiroto.
**Horst** (F. C. van der), Physician, *Malang*.
**Horsting** (Ir. W.) (1939), Forester, Madioen Forests, *Madioen*.
**Houbolt** (J. H.), Dept. of Mines, *Bandoeng*.
**Hout** (Drs. A. A. van der) (1938, 1939), Editor of Publications, Agricultural Extension Service, Dept. of Economic Affairs, *Batavia*.
**Houten** (Ir. L. van), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Houwink** (Dr. A. L.), Lecturer in Biology, College for Indonesian Physicians, *Soerabaja*.
**Hove** (Ir. W. ten) (1926, 1934), Extension Agronomist, Prov. Agricultural Extension Service, *Soerabaja*.
**Huart** (Dr. A. J.), Physician, *Tjimahi*.
**Huber** (Prof. Dr. F. L.) (1935, 1939), Director, Veterinary Research Institute, *Buitenzorg*.
**Hubers van Assenraad** (J. D. B.), First Pharmacist, and Chief, Pharmaceutical Stores, Dept. of War, *Bandoeng*.
**Huese** (J. P. F.), Technological Adviser, "Handelsmij. Amsterdam," *Soerabaja*.
**Huidekoper** (Ir. A. W.) (1931, 1934, 1938), Extension Agronomist, *Medan*.
**Huisman** (Ir. P. H.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Huitema** (H.), Chief, Bodjonegoro District of the Provincial Veterinary Service, *Bodjonegoro*.
**Huitema** (Dr. Ir. W. K.), Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Huizer** (A.), Supt., Rubber Plantation Kali Badjing, *Djember*.
**Huizinga** (Ir. L. H.), Office of the Census, *Batavia*.
**Hulssen** (Dr. C. J. van) (1937), Chemist, Phytochemical Div., Gen. Agricultural Experiment Station, *Buitenzorg*.
**Hulster** (Ir. I. A. de) (1938), Forester, Bodjonegoro Forests, *Bodjonegoro*.
**Hwan Hy Kie** (Ir.), Assistant (Harbour Construction, etc.), Institute of Technology, *Bandoeng*.
**Hylkema** (Ir. H. K.), Mining Engineer, Billiton Co., *Malili*, Celebes.
**Hyman** (Miss Ir. A. J.), Assistant, Medical College, *Batavia*.

**Idema** (Ir. J. G.) (1938), Extension Horticulturist, Dept. of Economic Affairs, *Batavia*.
**Idenburg** (Dr. A. G. A.), Geologist, Institute of Soils, General Agricultural Experiment Station, *Buitenzorg*.
**Inhiriwang** (Ir. F. J.), Office of the Census, *Batavia*.
**I Njoman Merati**, Archaeological Service, *Bali*.
**Iskandar** (Ir. R. G.) (1928), Extension Agronomist, Dept. of Economic Affairs, *Batavia*.
**Ismangil** (Pl. D. V. G.), Physician, *Soerabaja*.
**Iso Reksohadiprodjo** (Raden Mas), Head, Agricultural Extension Service for the Province Central Java, *Jokjakarta* (?).
**Iwema-Veldhuis** (Mrs. E. A. M.), Teacher of Biology, *Batavia*.

**Jackson** (A.), Assistant, Besoeki Experiment Station, *Djember*.
**Jacobs** (Dr. H.) (1937), Chemist (resins and gums), Laboratory for Chemical Research, *Buitenzorg*.
**Jager** (Ir. A. J. de), Mechanical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**James** (F.), Secretary, Experiment Station West Java, *Buitenzorg*.
**James** (Ir. W.), Chief Chemist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*, and Member of the Council, Neth. Chemical Society in the Neth. Indies.
**Jansen** (A. H. V.), Lecturer in Surveying, Graduate School of Agriculture, *Buitenzorg*.
**Jansen** (Ir. J.), Engineer, Div. of Radio Research of the Postal Administration, *Bandoeng*.
**Jansen van Raay** (Mr. Ir. J. F.), Engineer, Electric Power Division, Dept. of Roads and Waters, *Bandoeng*.
**Janssen** (J. P. J.), Technician, Institute of Technology, *Bandoeng*.
**Jansz** (A. J.), Office of the Census, *Batavia*.
**Japing** (Ir. H. W.) (1938), Chief Forester, Technological Div., Govt. Forest Research Institute, *Buitenzorg*.
**Jap Kie Ling** (Ir.), Technological Adviser, Oei Tiong Ham Sugar Factories, *Semarang*.
**Jelen** (E. J. van) (1935, 1938), Chief Sales Offices of the Govt. Forest Service, *Buitenzorg*.
**Jelles** (Ir. J. G. G.) (1931, 1937), Chief Forester, Tasikmalaja-Tjiamis Forests, *Garoet*.
**Jesse** (Ir. W. C.) (1938), Chief Forester, Eastern Borneo Forests, *Samarinda*.
**Johan** (Ir. J. F.), Extension Agronomist, in charge of the Banjoemas District, *Poerwokerto*.
**Jong** (A. de) (1931, 1937), Assistant, Textile Research Station, *Bandoeng*.
**Jong** (Dr. J. de) (1939), Chief, Div. of Marine Fisheries, Dept. of Economic Affairs, *Batavia*.
**Jong** (W. de) (1930, 1936), Chief Extension Horticulturist, *Batavia*.
**Jong** (Dr. Ir. W. H. de), Agronomist, Experiment Station Central and East Java at Malang, *Malang*.
**Jonge** (Miss J. A. de), Physician, *Modjowarno*.
**Jonge** (Ir. S. J. de), Engineer, Electric Power Div., Dept. of Roads and Waters, *Bandoeng*.
**Jongh** (Ir. P. H. de), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, Batavia.
**Jongh** (Dr. Ph. de), Microbiologist, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Jonker** (Ir. H. A. J.) (1938), Chief Forester, Tapanoeli Forests, *Taroetoeng*.
**Joosten** (Ir. J. H. L.) (1927, 1935), Extension Agronomist, Provincial Agricultural Experiment Service, *Batavia*.
**Jowangkai** (A.) (1931), Agricultural Assistant, Institute for Agricultural Technology, *Menado*.
**Julsing** (H. N.) (1937, 1938), Assistant for Agricultural Statistics, C. Statistical Office, *Batavia*.
**Justesen** (Ir. S. H.), Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg*.


FIGURE 126. — MAP OF JAVA, from "De eerste Schipvaerd der Hollandsche Natie naer Oost-Indien . . ." *in* "Begin ende Voortgangh van de Vereenighde Nederlantsche Geoctroyeerde Oost-Indische Compagnie" (1646). — *Courtesy Arnold Arboretum of Harvard University.*

**Juta** (Ir. E. H. P.) (1937), Forester, Ngandjoek Forest, *Ngandjoek*.

**Kalangie** (H.) (1939), Assistant, R. Meteorological Observatory, *Batavia*.
**Kaligis** (Dr. J. A.) (1934, 1939), Inspector, Govt. Veterinary Service, *Medan*.
**Kalshoven** (Dr. L. G. E.), Principal Zoologist, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Kampman** (Ir. G. C.) (1932, 1939), Chief Forester, Govt. Forest Service, *Buitenzorg*.
**Kan** (Ir. C. M.), Director, "Cultuur Mij. Watoetoelis-Poppoh."
**Kanter** (Drs. A. S. E. de), Office of the Census, *Batavia*.
**Kapp** (Ir. F.) (1928, 1936), Extension Agronomist, *Benkoelen*.
**Kariadi**, Physician, *Martapoera*.
**Karimoen** (Ch.), Chief, Pamekasan District, Prov. Veterinary Service, *Pamekasan*.
**Karstel** (W. J. J.) (1939), Forester, Palembang-Benkoelen Forests, *Loeboek Linggau*.
**Karthaus** (Dr. J. P.), Botanist, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Kaslan Abdoelah Tohir** (Ir.) (1939), Assistant, Div. of Agricultural Education and Publications, Div. of Agriculture, Dept. of Economic Affairs, *Buitenzorg*.
**Katwijk** (Ir. V. F. van) (1936, 1939), Chief Engineer, Central Purchasing Office, *Bandoeng*.
**Kau** (W. J. C.), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Keijzer** (Dr. C. J.) (1931, 1936), Lecturer, College for Indonesian Physicians, *Soerabaja*.
**Keizer** (Dr. D. P. R.), Pediatrician, *Soerabaja*.
**Kelder** (Ir. H. P.), Chemist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Kemper** (H. F. C.), Assistant, Besoeki Experiment Station, *Djember*.
**Kerkhof** (Ir. J. C. van), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Kerling** (Miss Dr. L. C.), Botanist, *Jogjakarta*.
**Kettlitz** (V. M. J.), Chief, Navy Medical Service, *Batavia*.
**Keuchenius** (Ir. J. R.), Head of General Engineering, South Sumatra Oilfields, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Keus** (J.) (1936, 1938), Div. of Marine Fisheries, Dept. of Economic Affairs, *Soerabaja*.
**Keverling Buisman** (Dr. A. S.), Professor (soils, etc.), Institute of Technology, *Bandoeng*.
**Keyzer** (Ir. A. W.) (1938), Extension Agronomist, *Samarinda*, Borneo.
**Kharnovsky** (Dr. V.), Biochemist, Java Sugar Expt. Station, *Pasoeroean*.
**Kinderen** (Ir. F. der) (1930,1937), Extension Agronomist, *Soerakarta*.
**Kirschner** (Dr. L.) (1939), Chief Govt. Physician, Vaccination Research Institute, *Bandoeng*.
**Kisman** (Dr. M.), Surgeon, *Menado*.
**Kiswarin** (1932), Forester, Pati Forest, *Pati*.
**Klamer** (Dr. G. H.) (1939), Research Associate, R. Meteorological Observatory, *Batavia*.
**Klasen** (Dr. H. J.), Chief, Veterinary Service for C. Java, *Semarang*.
**Kleinschmiede** (Ir. J.), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Klerk** (Ir. F. W. K. de) (1929, 1936), Chief Forester, Editor, and Librarian, Govt. Forest Service, *Buitenzorg*.
**Klerks** (Dr. J. V.), Nutrition Research Institute, *Batavia*.
**Kleyn** (Ir. W. M.) (1932, 1937), Chief Forester, Pemalang Forest, *Tegal*.
**Klinkert** (G. P.) (1928, 1933), Chief Forester, Director's Office, Govt. Forest Research Institute, *Buitenzorg*.
**Klinkhamer** (J. M.) (1933), Lecturer, School for Indonesian Dentists, *Soerabaja*.
**Klip** (Ir. R. B. A. van der) (1928), Chief Forester, Government Forest Service, *Buitenzorg* (?).
**Klokkers** (P. J.), Java Sugar Expt. Station, *Pasoeroean*.
**Knap** (M.) (1933), Lecturer, School for Indonesian Dentists, *Soerabaja*.
**Kock** (P. M. J. de), Physician, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Kodijat** (R.), Physician, *Kediri*.
**Koefoed** (Ir. H. G.) (1937), Extension Horticulturist and Adviser, Nutrition Research Institute, *Batavia*.
**Koefoed** (O.), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Koenigswald** (Dr. G. H. R. von), Palaeontologist, Palaeontological Laboratory, Div. of Geology, Dept. of Mines, *Bandoeng*. — Has been interned.
**Koesnoto** (Ir.), Assistant, Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Koiter** (D.) (1922, 1938), Chief Govt. Veterinarian, Govt. Veterinary Service, *Koetaradja*, Sumatra.
**Kok** (G.), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Kolb** (Ir. A. L.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Koning** (A. M. N.), Sugar Factory Kentjong.
**Koolhaas** (Dr. D. R.) (1939), Chief, Technical and Scientific Section, Industry Div., Dept. of Economic Affairs, *Batavia*.
**Koolhaas** (Ir. R. D.), Mechanical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Kools** (Dr. J. F.) (1938), Director, Forestry School, *Madioen*.
**Koopman** (Ir. M. J. F.) (1936), Forester, Director's Office, Govt. Forest Research Institute, *Buitenzorg*.
**Koopman** (Mrs. P. C.), Lecturer in Botany and Phytopathology, Graduate School of Agriculture, *Buitenzorg*.
**Kooy** (P.) (1938, 1939), Technical Chief, Div. of Marine Fisheries, Dept. of Economic Affairs, *Banjoewangi*.
**Kornmann** (W. C.), Lecturer (Athletics), Graduate School of Agriculture, *Buitenzorg*.
**Kortz** (A.) (1925, 1937), Forester, East Brantas Forest, *Malang*.
**Koster** (Ir. P.) (1928, 1935), Chief Forester, Sumatra West Coast Forests, *Fort de Kock*.
**Koster** (Drs. W.) (1937), Editor of Publications, Dept. of Economic Affairs, *Batavia*.
**Kostermans** (Dr. A. J. G. H.), Botanist, and Teacher of Biology, *Batavia*.
**Kostermans** (Dr. D. G. F. R.) (1937), Scientific Assistant, Eijkman Institute, *Batavia*.
**Kotter** (Dr. G. F.), Physician, *Koetaradja*.
**Kouwenaar** (Dr. W.), Pathologist, *Medan*.
**Kraay** (Dr. G. M.), Chief Chemist (Rubber), Neth. Indies Rubber Research Institute, *Buitenzorg*.
**Kraayenburg** (Mr. A. C.), Office of the Census, *Batavia*.
**Kramer** (Dr. Ir. F.), President, General Agricultural Syndicate, *Batavia*.
**Kramers** (Ir. C. A.) (1938), Scientific Assistant, Vaccination Research Institute, *Bandoeng*.
**Kraneveld** (Dr. F. C.) (1926, 1939), Bacteriologist, Veterinary Research Institute, *Buitenzorg*.
**Kreemer** (Dr. M. J.), Director, Planters Hospital, *Tandjong-karang*.
**Kreiken** (A. E.), Director, High School, *Soerabaja*.
**Krijger** (A. Th. A.), Sugar Factory Kaliwoengoe, *Kendal*.
**Krijnen** (W. F.), Geologist, % Head Office, Neth. Pacific Oil Co. (N.V. Nederl. Pacif. Petroleum Mij.), *Batavia*.
**Kroon** (Ir. A. H. J.) (1938), Chief, Section for Large Plantations, Div. of Agriculture, Dept. of Economic Affairs, *Batavia*.
**Kroon** (E. W. de), Assistant, Museum of the Geological Division, Dept. of Mines, *Bandoeng*.
**Kruijff** (Dr. J. P. H. de) (1917, 1926, 1933), Lecturer, College for Indonesian Physicians, *Soerabaja*.
**Kruithof** (A.) (1939), Assistant, Section for Large Plantations, Div. of Agriculture, Dept. of Economic Affairs, *Batavia*.
**Krull** (Ir. H.) (1938), Engineer and Chief, Wood Publicity Section, Govt. Forest Research Institute, *Buitenzorg*.
**Kruyt** (Ir. D. E. L.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Kündig** (Dr. A.) (1938), Inspector, Govt. Medical Service, *Makassar*.
**Kuilman** (Dr. C. W.), Botanical Laboratory, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Kuilman** (Dr. J.), Physician, *Bandoeng*.
**Kuilman** (Dr. L. W.), Botanist, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Kuip** (Ir. A. C. van der) (1929, 1937), Chief Forester, Garoet Forests, *Garoet*.
**Kuiper** (Ir. E. B.), Mechanical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Kuneman** Sr. (J. H.), Agronomist, Rubber Plantation Badek, *Kediri*.
**Kuyk** (Ir. S. van), Managing Director, Billiton Co., *Batavia*.
**Kuyper** (L.) (1939), Technical Assistant, Div. of Marine Fisheries, Dept. of Economic Affairs, *Soerabaja*.

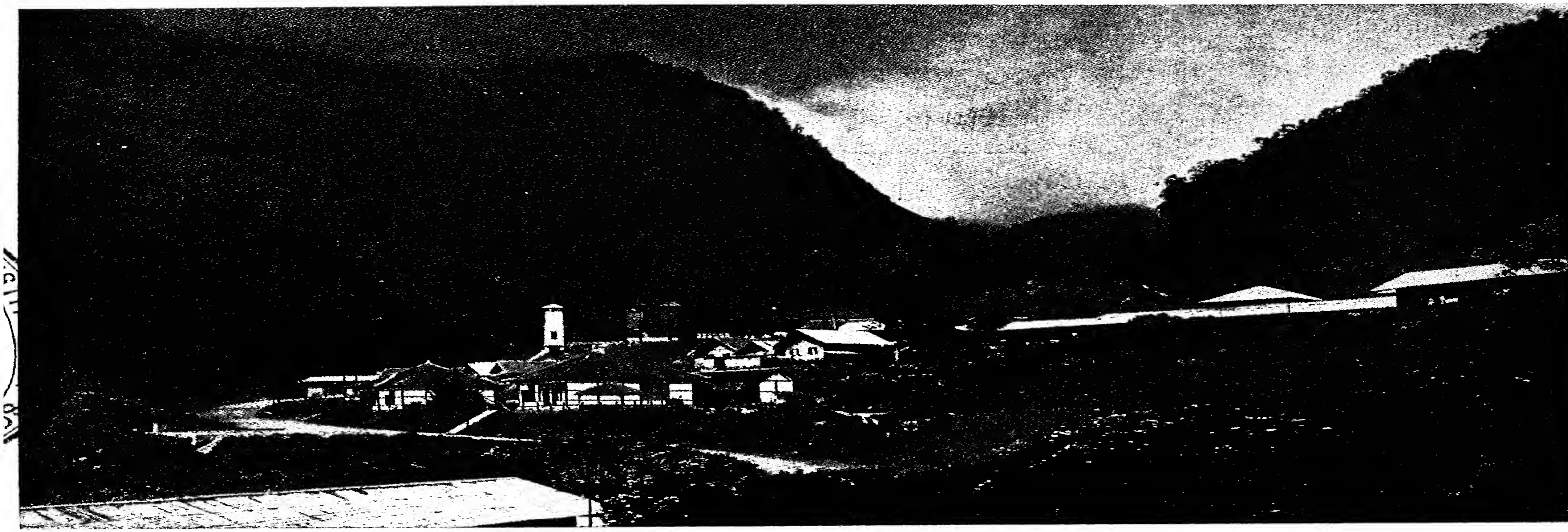

FIGURE 127. — THE MALABAR RADIO STATION NEAR BANDOENG.

**Laan** (Ir. G. W. van der) (1939), Extension Agronomist for Banka and Billiton, *Pangkalpinang*.
**Laan** (Dr. P. A. van der), Entomologist, Tobacco Experiment Station, *Medan*.
**Lagas** (D.) (1938), Inspector, Govt. Veterinary Service, *Makassar*.
**Lagimoen**, Technician, Medical College, *Batavia*.
[**Laive** (Ir. L. A. de), Mining Engineer, at present with the Dept. of Oil, Netherlands Representatives to the Combined Chiefs of Staff, *Washington*, D.C.]
**Lam** (Tjiook See), Asst., Java Sugar Expt. Station, *Pasoeroean*.
**Lameris** (A. J.), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Lammers** (Ir. R. P.), Geneticist, Besoeki Expt. Station, *Djember*.
**Lammerts van Buren** (B.), Pediatrician, *Soerabaja*.
**Lampe** (Ir. M.) (1929, 1934), Chief Forester, Indramajoe Forests, *Madjalengka*.
**Lampe** (Dr. P. H. J.) (1935, 1939), Director, Leprosy Research Institute, *Batavia*.
**Lamping** (Ir. E. A. E.) (1937), Extension Agronomist (Province East Java).
**Langen** (A. J. de) (1925, 1936), Forester, Tjepoe Forests, *Tjepoe*.
**Lanjouw** (L. R.), Technical Assistant, Herbarium, Govt. Botanic Gardens, *Buitenzorg*.
**Lankhorst** (W.) (1918, 1932), Govt. Veterinarian, Govt. Veterinary Service, *Batavia*.
**Lannee de Betrancourt** (K. de) (1938), Forester, Pati Forests, *Pati*.
**Lans** (A. J.) (1925, 1931, 1939), Adviser, Agricultural Extension Service, Dept. of Economic Affairs, *Batavia*.
**Lanzing** (Miss Dr. J. C.) (1936), Scientific Assistant, Eijkman Institute, *Batavia*.
**Lanzing** (Ir. W. J. R.), Chief Engineer, and Director, Ombilin Mines, *Sawahloento*.
**Lap** (P. O.), Geologist, % Head Office, Neth. Pacific Oil Co. (N.V. Nederl. Pacif. Petroleum Mij.), *Batavia*.
**Launy** (J. R.), Assistant for Agricultural Statistics, C. Statistical Office, *Batavia*.
**Laurens** (Mr. A.) (1939), Adviser, Dept. of Economic Affairs, *Batavia*.
**Lawick** (F. M. Baron van), "Nederl. Handelsmij.", *Batavia*.
**Leau** (Mr. H. de) (1936, 1938), Editor of Publications (Large Plantations), Dept. of Economic Affairs, *Batavia*.
**Leckie** (Dr. A. J.), Assistant (Physics), Institute of Technology, *Bandoeng*.
**Leenart** (Th. A.), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Leeuw** (Ir. H. A. L. de) (1928), Chief Forester, Govt. Forest Service, *Buitenzorg* (?).
**Leeuwen** (A. van), Supt., Rubber Plantation Pasir Ajoenan, W. Java.
**Leeuwen** (H. P. van), Sugar Factory Bandjaratma, *Tegal*.
**Leeuwen** (Ir. W. van), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Le Fevre** (Ir. A. J.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Leidelmeyer** (E. T. T.), Administrative Office, Institute of Technology, *Bandoeng*.
**Leimena** (Dr. J.), Physician, Missionary Hospital "Immanuel," *Bandoeng*.
**Lels** (Ir. H.), Inspector and Section Chief, Div. of Radio Research of the Postal Administration, *Bandoeng*.
**Lely** (Ir. C.), Mechanical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Lely** (Ir. J. van der), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Leniger** (Ir. H. A.), Chemist, N.I. Rubber Research Institute, *Buitenzorg*.
**Lennep** (H. van), Director, Govt. Plantations, *Batavia*.
**Le Nobel** (Ir. J. W.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Lever** (H.) (1925, 1933), Chief Forester, Govt. Forest Service, *Buitenzorg*.
**Levert** (Dr. Ir. Ph.), Phytopathological Institute, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Levie** (Dr. Ir. E. L.) (1931, 1938), Extension Horticulturist for Central Java.
**Levy-Davidson** (Miss M.) (1938), Chemist, Treub Laboratory, Govt. Botanic Gardens, *Buitenzorg*.
**Lian** (Dr. Sie Boen), Assistant, Medical College, *Batavia*.
**Lichte** (Ir. R.) (1939), Extension Agronomist, *Palembang*.
**Lieftinck** (M. A.) (1939), Chief, Zoological Museum and Laboratory, *Buitenzorg*.
**Ligt** (N. M. de), Coffee Planter and author of publications on coffee. — Died 1941.
**Lijnden** (Baron W. E. K. van) (1927, 1933), Extension Agronomist, Dept. of Economic Affairs (1940, on furlough).
**Limborgh** (Ir. J.), Electrotechnical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Lincklaen Arriëns** (Ir. R. A. L.) (1936, 1938), Extension Agronomist (Prov. Eastern Java).
**Lob** (Dr. Ir. G.), Chemist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Lobato** (Miss B. A.), Botanist, *Jogjakarta*.
**Lobel** (Dr. L. W. M.) (1936), Leprosy Research Institute, *Batavia*.
**Lochtenberg** (J. B. M.), Sales Office, Dept. of Mines, *Bandoeng*.
**Lodder** (Dr. J.), Physician, *Malang*.
**Loenen** (Ir. F. C. van), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Lörzing** (Ir. F. A.) (1939), Chief Forester, Govt. Forest Service, *Makassar*.
**Logemann** (J. B.), Chemist, "Mij. Sentanenlor c.s.", *Modjokerto*.
**Lohmann** (O. L. J. E.), formerly, Technological Adviser; Huize "Klim en Daal," Poentjakpas, *Buitenzorg*.
**Lom** (A. M. van), Sugar Factory Manishardjo, *Pedan*, Solo.
**Lonsain** (A. J. R.), Secretary, Neth. Indies Ornithological Society (1941), Pamanoekan and Tjiasemlanden, *Soebang*.
**Loos** (Dr. H.) (1932, 1933, 1936, 1939), Inspector, Govt. Agricultural Extension Service (Govt. Sumatra), *Medan*.
**Louwerse** (Ir. A. J.) (1928, 1934), Chief Forester, Office of the Principal Silviculturist, Govt. Forest Service, *Buitenzorg*.
**Lucardi** (G. W. F.) (1938), Lecturer in Tropical Hygiene, First Aid, etc., Training School for Policemen, *Soekaboemi*.
**Lugard** (L. G.), Agriculturist, % Experiment Station Central and East Java at Malang, *Malang*.
**Lugten** (C. H.), Assistant (Architecture), Institute of Technology, *Bandoeng*.
**Luijke Roskott** (Dr. E. R. A., Physician, *Soerabaja*.
**Luytjes** (A.) (1938), Director, Div. of Agriculture, Dept. of Economic Affairs, *Batavia*.

**Maarel** (T. H. van den), Geologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Maas** (Dr. J. A.), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Maas** (Dr. J. G. J. A.), General Manager, Deli Batavia Rubber Co., near *Medan*.
**Maas** (Ir. M. W.), Electrical Engineer, Refineries, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Maas Geesteranus** (Ir. W.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Maas** (O. P. E.) (1939), Technician, Govt. Forest Research Institute, *Buitenzorg*.
**MacGillavry** (Dr. H. J.), Paleontologist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Machsoes**, Physician, *Serang*.
**Maclaine Pont** (Ir. H.), Archaeologist, *Modjokerto*.
**Magielse** (M. M.) (1936, 1938), Horticulturist (Dept. of Economic Affairs), *Malang*.
**Mahjoedin**, Lecturer in Agriculture, Planters School, *Malang*.
**Maier** (Ir. O. R.), Chief Engineer and Inspector (Exterior Districts), Dept. of Roads and Waters, *Medan*.
**Makaliwy** (Ir. A. A. G. P.) (1931), Extension Agronomist and Adviser to Indonesian Immigrants, *Bandjermasin*.
**Mamoto** (Mas), Chemist, Besoeki Experiment Station, *Djember*.
**Mansvelt** (Dr. W. M. F.) (1939), Tempor. Director, Office of the Census, Dept. of Economic Affairs, *Batavia*.
**Marchés** (J.), Technologist, Java Sugar Experiment Station, *Pasoeroean*.
**Marel** (Dr. Ir. H. W. van der), Laboratory for Soil Research, V. O. Bah Djambi, Sumatra.
**Marjitno** (Mas), Physician, *Soerabaja*.
**Markies** (Ir. P. H.), Engineer, Hydroelectric Power Div., Dept. of Roads and Waters, *Bandoeng*.


FIGURE 128. — ONE OF THE BEAUTIFUL BOTANICAL HABITUS DRAWINGS (Tab. 95) BY PAYEN (LITHOGRAPHED BY LAUTERS) FROM BLUME'S *Rumphia* (1835 *seq.*).

**Markus** (Ir. B.) (1935), Extension Ichthyologist (Fresh Water Fisheries), *Buitenzorg*.
**Marseille** (A.), Physician, *Ambon*.
**Martin** (W. C.), Observator, Bosscha Astronomical Observatory, *Lembang*.
**Marzoeki Mahdi**, Lecturer in Hygiene and First Aid, Graduate School of Agriculture, *Buitenzorg*.
**Mathol** (A. F.) (1939), Extension Horticulturist, *Malang*.
**Max** (Drs. H. J. N.), Sugar Factory Meritjan, *Kediri*.
**Medema** (H.), Chemist, Sugar Factory Kalibagor, *Soekaradja*.
**Meer Mohr** (Dr. J. v. d.), Teacher in Biology, Municipal Junior College, *Medan*.
**Meesters** (Ir. G.), Chief Engineer (New Constructions), Div. of Waters, Dept. of Roads and Waters, *Bandoeng*.
**Meeteren** (A. van), Physician, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Meijer Drees** (Dr. Ir. E.), Silviculturist, Forest Service, Sumatra or Celebes.
**Meijer** (Dr. Th. M.), Chemist, Laboratory for Chemical Research, *Buitenzorg*.
**Meijers** (F. M.), Physician, *Galang*.
**Meijs** (Ir. H. G. W.) (1938), Chief Forester, Tjiledoek Forest, *Tjiledoek*.
**Meijs** (Ir. P. C. J.) (1930, 1936), Chief Forester, Palembang-Benkoelen Forests, *Palembang*.
**Menden** (J. J.), Zoological Collector, *Cheribon*. — Has been interned.
**Mennes** (H. M. M.) (1938), Adviser (Large Plantations Section), Dept. of Economic Affairs, *Batavia*.
**Menrath** (Ir. H.), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Mente** (F. L.) (1925, 1935), Forester, Modjokerto Forests, *Modjokerto*.
**Mentel** (K. G. V.) (1924), Chief, Information Bureau for Small Industries, Dept. of Economic Affairs, *Batavia*.
**Merens** (T. E. Ch.) (1918, 1932), Govt. Veterinarian, Govt. Veterinary Service, *Poerwokerto*.
**Merkens** (Dr. J.) (1937), Director, Veterinary College, *Buitenzorg*.
**Merkus** (C. R.) (1939), Chief, Laboratory for Navigation Instruments, Navy Yard, *Soerabaja*.
**Mertens** (Dr. W. K.) (1934), Director, Eijkman Institute, *Batavia*.
**Mettivier Meyer** (Ir. J. C.) (1936, 1939), Extension Ichthyologist, *Soerabaja*.
**Meulemans** (Ir. L.), Chemist, Neth. Indies Roads Society, *Bandoeng*.
**Meulemans** (Ir. O.), Assistant, Medical College, *Batavia*.
**Meulen** (Dr. A. van der) (1939), Horticultural Assistant, Botanical Laboratory, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Meulen** (Ir. C. W. J. van der), temporary Assistant, Java Sugar Experiment Station, *Pasoeroean*.
**Meulen** (Ir. J. G. J. van der), Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Meulen** (Ir. R. van der) (1939), Forester, Mantingan Forest, *Mantingan*.
**Meurs** (Dr. A.), Botanist, *Karangdinojo* near Paree.
**Meyer** (F. H.) (1939), Govt. Physician, Laboratory of the Govt. Medical Service, *Soerabaja*.
**Meyer** (H.), Geologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Meyer** (Ir. L. A.) (1938), Extension Agronomist (Riouw District), *Rengat*.
**Meyer** (Dr. Th. M.) (1935, 1938), Phytochemist, Laboratory for Chemical Research, *Buitenzorg*.
**Meyer** (W. C. Ph.) (1928, 1936), Chief Govt. Veterinarian, *Singaradja*.
**Meyneken** (Ir. F. A. W.), Engineer, Div. of Harbours, Dept. of Roads and Waters, *Bandoeng*.
**Michaël** (Ir. J. G.), Sugar Factory Tandjongtirto.
**Michielsen** (Ir. W. J. M.), Technologic-Chemical Adviser, Tiedeman & van Kerchem Co., *Soerabaja*.
**Middelaer** (F. H. V.) (1929, 1931, 1938), Vice-Director, Dept. of Economic Affairs, *Batavia*.
**Middelberg** (Ir. G. A. A.), Mechanical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Middelburg** (Ir. D. J. A.) (1927, 1934), Assistant for Agricultural Statistics, C. Statistical Office, *Batavia*.
**Middelburg** (Dr. Ir. H. A.), Director, Tobacco Experiment Station, *Klaten*.
**Mijers** (Dr. W. N.) (1938), Chief Forester, Kangean-Madoera Forests, *Pamekasan*.
**Mijsberg** (Dr. W. A.), Professor of Anatomy, Embryology and Anthropology, Medical College, *Batavia*.
**Miller** (Dr. P. A.), Chemist, Plantation Research Dept., U. S. Rubber Plantations, Inc., *Boenoet*, Kisaran.
**Minnigh** (Ir. L. D.), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Mochtar** (Raden), Chief, Information Bureau for Medicine and Hygiene, *Batavia*.
**Moehamad Safeï** (Raden), Asst. Botanist, General Agricultural Experiment Station, *Buitenzorg*.
**Moelia Toerman Sihombing**, Govt. Veterinarian, Govt. Veterinary Service, *Roeteng*.
**Moens** (Ir. J. L.), Archaeologist, *Jogjakarta*.
**Moestopo** (Raden) (1938), Lecturer, School for Indonesian Dentists, *Soerabaja*.
**Moetadji Kartodirdjo** (Raden), Govt. Veterinarian, Govt. Veterinary Service, *Soembawabesar*.
**Moewardi** (Dr.), Assistant, Medical College, *Batavia*.
**Mohamad Idris** (1936), Govt. Veterinarian, Govt. Veterinary Service, *Koepang*.
**Mohamad Sjaäf** (Dr.) (1931), Lecturer, College for Indonesian Physicians, *Soerabaja*.
**Mohr** (Dr. E. J.), Physician, *Batavia*.
**Mol** (Ir. C. J.) (1938), Chief Forester, Pekalongan Forests, *Pekalongan*.
**Mol** (Ir. D.) (1934), Forester, Djambi Forests, *Djambi*.
**Mol** (Ir. G. A. de) (1932, 1939), Extension Agronomist, Dept. of Economic Affairs, *Buitenzorg*.
**Mol** (Dr. Ir. W. de), Botanist, Timbang Langkat Plantation, *Bindjei* (Sumatra E. C.).
**Molen** (L. van der), Physician, *Tandjong Morawa*.
**Mom** (Prof. Dr. Ir. C. P.) (1930, 1934), Director, Laboratory for Technical Hygiene, and Professor of Chemistry, Institute of Technology, *Bandoeng*.
**Monchy** (H. M. de), Physician, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Mooij** (W.), Physician, *Batavia-C*.
**Moor** (Dr. C. E. de) (1937), Govt. Physician, Laboratory of the Govt. Medical Service, *Makassar*.
**Mreijen** (F. W.), Pharmacological Lab., College of Medicine, *Batavia*.
**Müller** (Dr. H.) (1926, 1935), Lecturer, College for Indonesian Physicians, *Soerabaja*.
**Mulder** (Ir. G. W.) (1937), Forester, Director's Office, Govt. Forest Research Institute, *Buitenzorg*.
**Mulder** (Ir. L. H. D.), Chief Agricultural Extension Service Semarang (Prov. Council for Central Java), *Semarang*.
**Mulholland** (J. J.), Expt. Station Central and East Java, *Malang*.
**Mulock Houwer** (A. W.), Professor of Ophthalmology, Medical College, *Batavia*.
**Munnik** (Dr. F. J.) (1918, 1934), Govt. Veterinarian, Govt. Veterinary Service, *Batavia*.
**Munter** (J. W.), Sugar Factory Koenir, *Ngoenoet*.
**Musper** (K. A. F. R.), Geological Museum, *Bandoeng*.
**Mutter** (J. F.) (1928, 1935), Assistant, Batik Research Station, *Jogjakarta*.

**Naber** (Ir. R.), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Nanning** (W.), Physician, *Paloe*.
**Neef** (J. C. de), Assistant (Rubber), Experiment Station West Java, *Buitenzorg*.
**Neervoort**, Asst. Hortulanus, Government Botanic Gardens, *Buitenzorg*.
**Nelissen** (Ir. Th.), Engineer, Dept. of Mines, *Bandoeng*.
**Neuteboom** (Ir. J. D.) (1939), Extension Agronomist for Minangkabau, *Padang*.
**Niebroek** (H.) (1927, 1934), Chief Forester, Bodjonegoro Forests, *Bodjonegoro*.
**Niemans** (C. J. A. M.) (1938), Adviser (Industry Section), Dept. of Economic Affairs, *Batavia*.
**Nijenhuis** (Ir. H.) (1938), Chief Forester, Govt. Forest Service, *Soerabaja*.
**Nijholt** (Ir. J. A.) (1934, 1936, 1937), Chemist, Laboratory for Chemical Research, *Buitenzorg*.
**Noorda** (Ir. J. van der), Architect, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Noosten** (H. H.), Surgeon and Zoologist, *Medan*.
**Nooy** (Dr. J. A. de), Inspector, Prov. Medical Service, *Soerabaja*.
**Nordheim** (Ir. W. F. A. van), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.

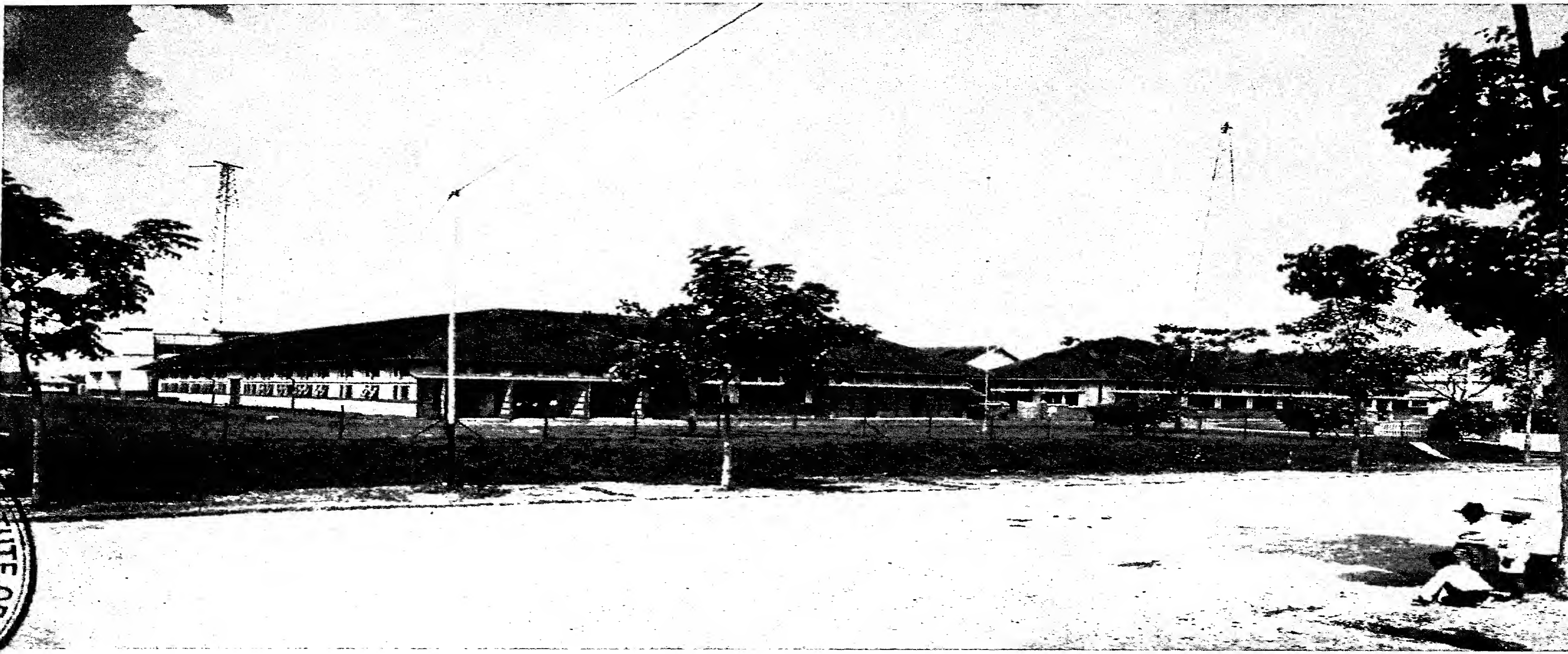

FIGURE 129. — RADIO RESEARCH LABORATORIES OF THE GOVERNMENT POSTAL ADMINISTRATION IN BANDOENG. — *Courtesy Netherlands Information Bureau, New York City.*

**Noteboom** (G. A.) (1921, 1927, 1936), Extension Horticulturist.
**Notenboom** (Ir. A. W.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Nugteren** (Ir. W. L.) (1938), Engineer, C. Purchasing Office, *Bandoeng.*

**Ochse** (J. J.) (1939), Head, Div. of Domestic Trade, Dept. of Economic Affairs, *Batavia.*
**Ockerse** (G. A. O.), Technician, Medical College, *Batavia.*
**Odang Prawiradiredja** (Raden) (1932), Forester, Madioen Forests, *Madioen.*
**Odenthal** (Ir. D. W.), Lecturer (Engineering), Graduate School of Agriculture, *Buitenzorg.*
**Oemarsanoesi** (Mas), Assistant Extension Agronomist, *Jogjakarata.*
**Oesman Natawidjaja** (1938, 1939), Editor of Publications, Agricultural Extension Service, Div. of Agronomy, Dept. of Economic Affairs, *Batavia.*
**Oey Djoen Seng**, Wood Technologist, Govt. Forest Research Institute, *Buitenzorg.*
**Oey Khoen Lian**, Physician, *Batavia.*
**Olivier** (P. H.), Lecturer, Medical College, *Batavia.*
**Olthof** (J.), Conservator, Zoological Museum and Laboratory, *Buitenzorg.*
**Omme** (Ir. J. van) (1938), Chief Forester, Government Forest Service, *Djember.*
**Oomen** (Dr. H. A. P. C.), Physician, *Rangkasbitoeng.*
**Oosten** (Ir. W.), Mining Engineer, Representative, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Oosterhoff** (Ir. J. A.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Oostingh** (Ir. C. H.), Geological Div., Dept. of Mines, *Bandoeng.*
**Ophof** (Ir. A. J.), Agronomist, Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Orsoy de Flines** (E. W. van), Conservator, Ceramic Collections, Kon. Bataviaasch Genootschap van K. en W., and Adviser on Ceramics to the Director of the Archaeological Service and Museum, *Batavia.*
**Ortt** (Jhr. Ir. C.), Lecturer (Highway Construction), Institute of Technology, *Bandoeng.*
**Ostendorf** (Dr. F. W.), Geneticist (*Cacao*), Experiment Station Central and East Java, *Semarang.*
**Otten** (Dr. Ir. G.), Extraord. Prof. of Applied Mechanics, Institute of Technology, and Head, Technical Service, Army Air Forces, *Bandoeng.*
**Otten** (Prof. Dr. L.) (1924, 1928, 1934), Director, Vaccination Research Institute, *Bandoeng.*
**Otten-van Stockum** (Mrs. M. J.), (1934, 1935), Govt. Physician, Vaccination Research Institute, *Batavia.*
**Ottow** (Ir. A.) (1929, 1935), Chief Forester, Saradan Forest, *Madioen.*
**Ottow** (M.), Coffee Planter and author of publications on coffee growing.
**Ouborg** (T. J.), Chief, Printing Office, Topographical Survey, *Batavia.*
**Outer** (Ir. M. W. den), Engineer, Section for Hydraulics, Electric Power Div., Dept. of Roads and Waters, *Bandoeng.*
**Overbeek** (J. G.), Physician (Malaria), *Batavia.*
**Overbeek** (Ir. J. Th.) (1934), Forester, Kebonhardjo Forest, *Kebonhardjo.*
**Overstraeten Kruyse** (Ir. A. van), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Oyens** (A. W. van) (1941), Physician, Navy Yard, *Soerabaja.*

**Paap** (A.), Geologist, % Head Office, Neth. Pacific Oil Co. (N.V. Nederl. Pacif. Petroleum Mij.), *Batavia.*
**Paasschen** (F. van) (1933, 1936), Asst.-Director, Govt. Printing Office, *Bandoeng.*
**Pabbruwe** (Ir. H.), Mechanical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Paneth** (Dr. O.), Physician, *Kabandjahe.*
**Pannekoek** (Dr. A. J.), Geographer, Topographical Service, *Batavia.* — Editor of "N. I. Geogr. Mededeelingen."
**Pannekoek-Westenburg** (S. J. E.), College of Medicine, *Batavia.*
**Paszotta** (Miss L.), Asst. Librarian, Institute of Technology, *Bandoeng.*
**Peereboom Voller** (Ir. L. H. N. L.), Electrotechnical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Peereboom** (N. J.), Consulting Agriculturist to the "N. V. Kooy & Co.," *Soerabaja.*
**Pel** (H. van) (1932, 1936), Technical Assistant, Div. of Marine Fisheries, Dept. of Economic Affairs, *Batavia.*
**Pel** (Ir. W. A. H.), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Peltwijk** (J. D. ter), Biologist, Fisheries Research Institute, *Batavia.*
**Peltzer** (F. A.) (1938), Assistant, R. Meteorological Observatory, *Batavia.*
**Penders** (Ir. J. M. A.), Agronomist, Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Perk** (Ir. A.) (1930, 1938), Extension Agronomist for Bali and Lombok, *Singaradja.*
**Perk** (Ing. C. G. M.), Technologic-Chemical Adviser to the Neth. Indies Agricultural Society, *Soerabaja.*
**Pet** (Dr. M. A.), Laboratory of the Govt. Medical Service, *Soerabaja.*
**Petrie** (Ir. A. P.), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Petroeschevsky** (W. A.), Vulcanologist, Dept. of Mines, *Bandoeng.*
**Pettinga** (J. J.) (1930, 1937), Govt. Veterinarian, Govt. Veterinary Service, *Menado.*
**Pfältzer** (Dr. A.), Phytopathologist, Experiment Station West Java, *Buitenzorg.*
**Pfältzer-Birnie** (Mrs. A. M.), Biologist, *Buitenzorg.*
**Pflugbeil** (Dr. E. R.) (1934, 1936), Inspector, Sumatra District, Govt. Medical Service, *Medan.* — Has been interned.
**Philippi** (Dr.), Geologist, *Bandoeng.*
**Picard** (Dr. W. K.) (1934), Chief Government Veterinarian, *Medan.*
**Piederiet** (J. G.), Master, Graduate School of Forestry, *Madioen.*
**Pieters** (Dr. J. M.), Agricultural Adviser, Dept. of the Interior, *Batavia.*
**Pijl** (Dr. L. van der), Teacher in Biology, Christian Lyceum, *Bandoeng.*
**Plaats-Keyzer** (Mrs. A. van der), Physician, *Batavia.*
**Plaats** (Dr. B. J. van der), Professor of Radiology, Medical College, *Batavia.*
**Plasman** (P. H. M.), Chief, Land Registry, Dept. of Justice, *Batavia.*
**Ploeg** (Ir. J. van der) (1927, 1934), Extension Agronomist, Dept. of Economic Affairs, *Batavia.*
**Pock Steen** (Dr. P. H.), Physician, *Bandoeng.*
**Poelma** (H. M.), Sugar Factory Ngadiredjo, *Kras* SS/OL.
**Pol** (A. van de), Nutrition Research Laboratory, *Batavia.*
**Polak** (Miss Dr. B.), Research Associate (Peat), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Polderman** (Ir. H. A.) (1930, 1935, 1938), Extension Agronomist for Minangkabau, *Padang.*
**Poldermans** (Ir. P. J.), Java Sugar Expt. Station, *Pasoeroean.*
**Poldervaart** (Ir. P. H.), Extraord. Prof. of Surveying and Geodetics, Institute of Technology, *Bandoeng.*
[**Polk** (Dr. L.), at present at *Brisbane* (Australia).]
**Polman** (H.) (1929, 1933), Extension Horticulturist for Eastern Java.
**Polvliet** (Dr. A. C.), Chemist (Soils), Tobacco Experiment Station, *Medan.*
**Pomes** (Ir. H.), Engineer (Tin Processing), Banka Tin Mines, *Banka.*
**Pomes** (Ir. K. E.), Architect, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Pons** (Dr. L.), Research Associate, Nutrition Research Institute, *Soerabaja.*
**Poorten** (Ir. A. C. ter), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Pootjes** (J. R.), Phytopathological Institute, General Agricultural Experiment Station, *Buitenzorg.*
**Posthumus** (Dr. K.), Member of the Council, Neth. Chemical Society, Neth. Indies Branch, *Bandoeng.*
**Posthumus** (Dr. O.), Director, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Postma** (A.) (1939), Horticulturist of the Gen. Agricultural Experiment Station, *Djatipadang* near Pasarminggoe.
**Postma** (G. W.), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Postma** (Mr. T. F. H.), Secretary, "Algemeen Syndicaat van Suikerfabrikanten in Nederl.-Indië", *Soerabaja.*

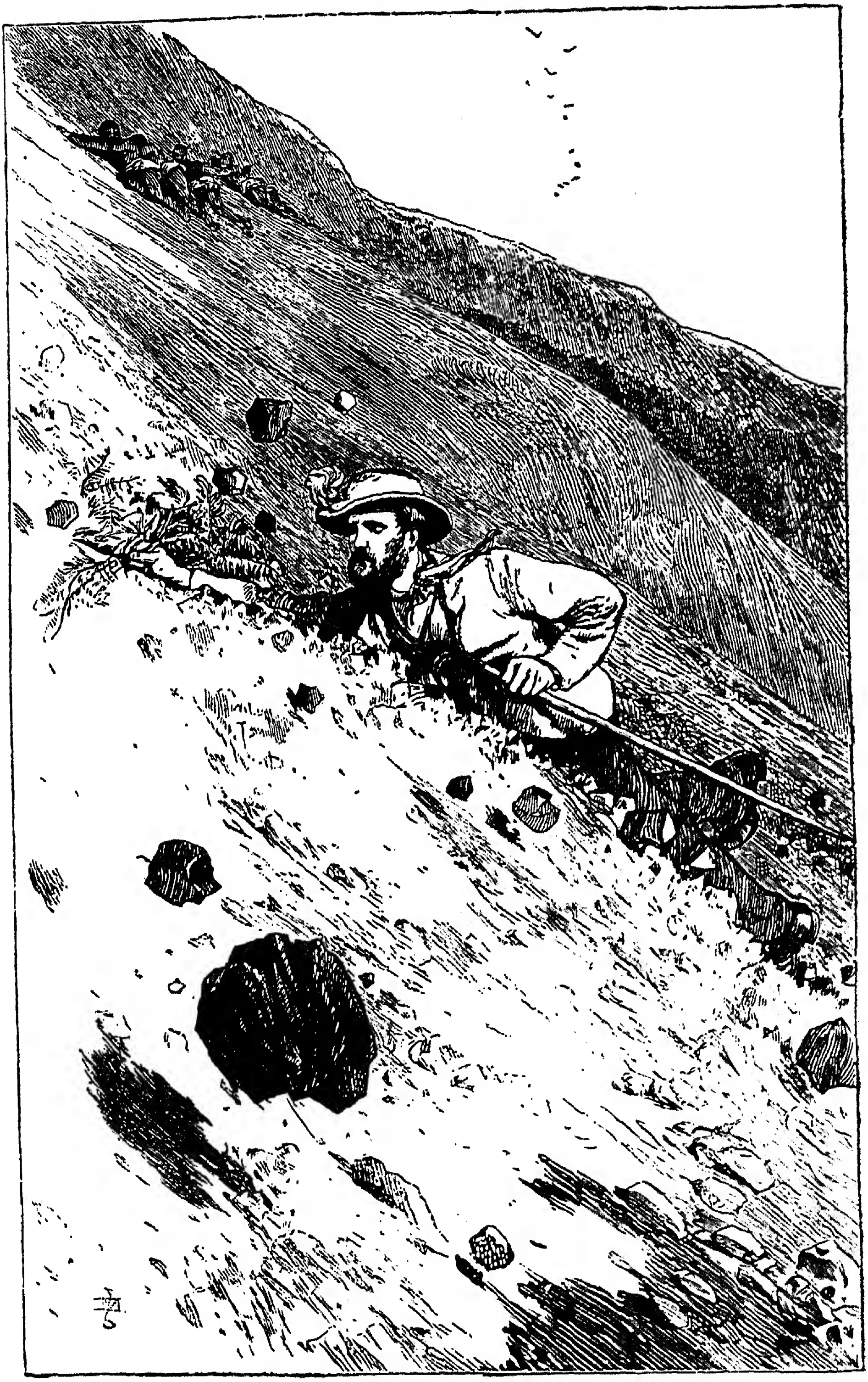

FIGURE 130. — "SAVED BY GRASPING A FERN"; Adventure of a British Naturalist on Lontar (from A. S. BICKMORE'S Travels in the East Indian Archipelago, 1869).

**Postmus-de Does** (Mrs. R.), Librarian, R. Neth. Indies Science Society, *Batavia.*
**Postmus** (Dr. S.), Director, Nutrition Research Institute, *Batavia.*
**Pott** (Ir. G.), Assistant for Geological Cartography, Dept. of Mines, *Bandoeng.*
**Pril** (Ir. J. de), Divisional Head, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Prillwitz** (Dr. P. M. H. H.) (1936), Adviser (Large Plantations), Div. of Agriculture, Dept. of Economic Affairs, *Batavia.*
**Prins** (H. J.) (1925, 1935), Forester, Bodjonegoro Forest, *Bodjonegoro.*
**Probstfield** (E. E.), Forester, Botanical Div., Plantation Research Dept., U. S. Rubber Plantations, Inc., *Boenoet,* Kisaran.
**Proper** (Ir. J. W. F. C.), Professor of Hydraulics, Institute of Technology, *Bandoeng.*
**Pruis** (G. W. A.), Physician, *Kadipaten.*
**Punt** (J. R.) (1938), Chemist, Govt. Forest Research Institute, *Buitenzorg.*
**Pijper** (T. de), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Pijpers** (P. J.), Geologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*

**Quant** (Ir. C. L. J. J.) (1936, 1938, 1939), Director, Central Purchasing Office for the Neth. Indies, and Lecturer (Railways), Institute of Technology, *Bandoeng.*

**Raad** (Ir. A.) (1938), Forester, Toeban Forest, *Toeban.*
**Raadsen** (Ir. P.), Mechanical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Raaff** (Ir. Th. E.), Secretary, Besoeki Experiment Station, *Djember.*
**Raalte** (Dr. M. H. van) (1939), Temp. Director, Visitors' Laboratory, Govt. Bot. Gardens; formerly, Assistant for Horticultural Physiology, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Rademaker** (Ir. E.), Engineer, Irrigation Section, Div. of Waters, Dept. of Roads and Waters, *Bandoeng.*
**Rademaker** (Ir. J.), Civil Engineer, Refineries, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*
**Radsma** (Dr. W.), Professor of Physiological Chemistry and Histology, Medical College, *Batavia.*
**Ramkema** (A. J.) (1928, 1934), Forester, Govt. Forest Service, *Malang.*
**Ran** (C. J. R.) (1935), Lecturer, College for Native Physicians, *Soerabaja.*
**Rant** (Dr. A.), Hon. Research Associate, Govt. Botanic Gardens, *Buitenzorg.*
**Rappard** (Ir. W.) (1934), Forester, Tjepoe Forest, *Tjepoe.*
**Rasjid** (Abdul), Physician, and Member, Advisory Committee for Native Drug Plants, *Batavia.*
**Raven** (Ir. P.), Engineer, Technological Div., Dept. of Mines, *Bandoeng.*
**Ravenswaay** (Ir. H. A.), Mechanical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Razoux Schultz** (Ir. F. M.) (1936), Chief Engineer, Govt. Medical Service, *Batavia.*
**Reddingius** (Dr. T.), Professor of Clinical Medicine and Orthopedics, Medical College, *Batavia.*
**Reede** (C. A. de), Physician, *Tandjong-Priok.*
**Reeling Knap** (C.), Physician, *Magelang.*
**Rees** (Major-General J. van), Director, Military Medical Service, Dept. of War, *Bandoeng.*
**Reest** (H. J. Ch. van der) (1918, 1935), Govt. Veterinarian, Govt. Veterinary Service, *Soerakarta.*
**Regeer** (Ir. J.), Engineer, Irrigation Section, Div. of Waters, Dept. of Roads and Waters, *Bandoeng.*
**Reijnierse** (W.), Physician, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Reitsma** (Dr. J.), Phytopathologist, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Remmelts** (Dr. R.), Professor of Gynaecology, Medical College, *Batavia.*
**Rengers Hora Siccama** (Jhr. Mr. G. F. H. W.), Member of the Council, Neth. Indies Ornithological Society, and Neth. Indies Society for Nature Protection, *Batavia.*
**Ressing**, Institute for Agricultural Technology, General Agricultural Experiment Station, *Buitenzorg.*
**Reurink** (Ir. C. H.) (1937), Forester, Balapoelang Forest, *Balapoelang.*
**Reuter** (Dr. J.), Biologist, Fisheries Research Institute, *Batavia.*
**Reuter** (Ir. K. N.) (1936, 1938), Extension Agronomist (for W. Java), Div. of Agriculture, Dept. of Economic Affairs, *Batavia* (?).
**Reynvaan** (J.) (1930, 1934), Section for Agricultural Publications and Education, Dept. of Economic Affairs, *Batavia.*
**Rhee** (Ir. P. van), Adviser, Central Technological Laboratories, *Buitenzorg.*
**Rhines** (Dr. C. E.), Chemist, Plantation Research Dept., U. S. Rubber Plantations, Inc., *Boenoet,* Kisaran.
**Richard** (Ir. H. A.) (1938), Forester, Poerwodadi Forest, *Poerwodadi.*
**Riele** (Ir. H. J. te), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Riepman**, Central Technological Laboratories, *Batavia.*
**Rierink** (Ir. A.) (1936), Forester, Djember Forests, *Djember.*
**Rijke** (Ir. L. de) (1938), Chief Forester, Atjeh Forests, *Koeta-Radja.*
**Rijkebüsch** (Miss E. J.), Assistant, Medical College, *Batavia.*
**Rijkebüsch Jr.** (P. A. H.), Sugar Factory Tjandi, *Sidoardjo.*
**Rijkebusch-Lombart** (Mrs. A.), Physician, *Batavia.*
**Rikken** (Ir. L. H.) (1937), Forester, South Borneo Forests.
**Risseeuw** (Ir. P.) (1938), Chief Forester, Timor Forests, *Koepang.*
**Rockland** (J. G. R.), Chemist, Experiment Station of the Association of Sumatra Rubber Growers, *Medan.*
**Roderkerk** (Ir. E. C. M.) (1936), Forester, Palembang-Benkoelen Forests, *Kepahiang.*
**Roeloffs** (Ir. J. W.) (1932, 1939), Chief Forester, and Secretary, Commission for the Introduction of New Economic Plants, *Batavia.*
**Roelofsen** (Dr. P. A.), Director, Tobacco Experiment Station, *Medan.*
**Römer** (L. S. A. M. von), Physician, *Malang.*
**Roesiat alias Mangoenwigate** (Steph.) (1932), Forester, Semarang Forest, *Kedoengdjati.*
**Roessing van Itterson** (Ir. J. A.), Chemist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*
**Roggeveen** (P. M.), Geologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Rolvink** (Ir. W.) (1938), Chief Forester, Bondowoso Forests, *Bondowoso.*
**Rombach** (J. J.) (1939), Secretary, Dept. of Economic Affairs, *Batavia.*
**Rombouts** (H. E.), Physician, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Romondt** (Ir. V. R. van), Construction Inspector, Archaeological Service and Museum, *Jogjakarta.*
**Ronggoer gelar Patoean Malaon** (1931), Forester, Tapanoeli Forests, *Taroetoeng.*
**Ronnen** (J. R.), Roentgenologist, Military Hospital, *Malang.*
**Roo** (Ir. H. C. de), Pedologist, Prov. Agricultural Extension Service, *Soerabaja.*
**Rood** (Ir. de), Institute of Soils, General Agricultural Experiment Station, *Buitenzorg.*
**Rook** (Dr. H. de), Entomologist, *Medan.*
**Roorda** (A.) (1929, 1930, 1939), Extension Ichthyologist, *Pamekasan.*
**Roos** (Ir. J.) (1928, 1929, 1935), Extension Agronomist, Dept. of Economic Affairs, *Batavia.*
**Roosseno Soerjohadikoesoemo** (Ir. Raden), Assistant (Surveying), Institute of Technology, *Bandoeng.*
**Rooy** (W. F. J. van) (1921, 1937), Govt. Veterinarian, Govt. Veterinary Service, *Cheribon.*
**Roozendaal** (Dr. N. A.), Inspector, and Pharmaceutical Adviser, Govt. Medical Service, *Batavia.*
**Ros** (F. W.) (1925, 1934), Forester, Timor Forests, *Koepang.*
**Rosenwald** (Ir. P. J.), Electrotechnical Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Rossem** (A. N. J. van), Assistant, Experiment Station of the Association of Sumatra Rubber Growers, *Medan.*
**Rotteveel** (A. W.), Institute of Soils, General Agricultural Experiment Station, *Buitenzorg.*
**Rubly** (O. H.) (1929), Technician, School for Indonesian Dentists, *Soerabaja.*
**Rühl** (D.), Librarian, Central Library of the Dept. of Roads and Waters, *Bandoeng.*
**Rümke** (Dr. C. L.), Geneticist, Java Sugar Experiment Station, *Pasoeroean.*
**Ruinen** (Miss Dr. J.), Assistant, Director's Office, Govt. Botanical Gardens, *Buitenzorg.*
**Rumbold** (J. S.), Chemist, Plantation Research Dept. U. S. Rubber Plantations, Inc., *Boenoet,* Kisaran.

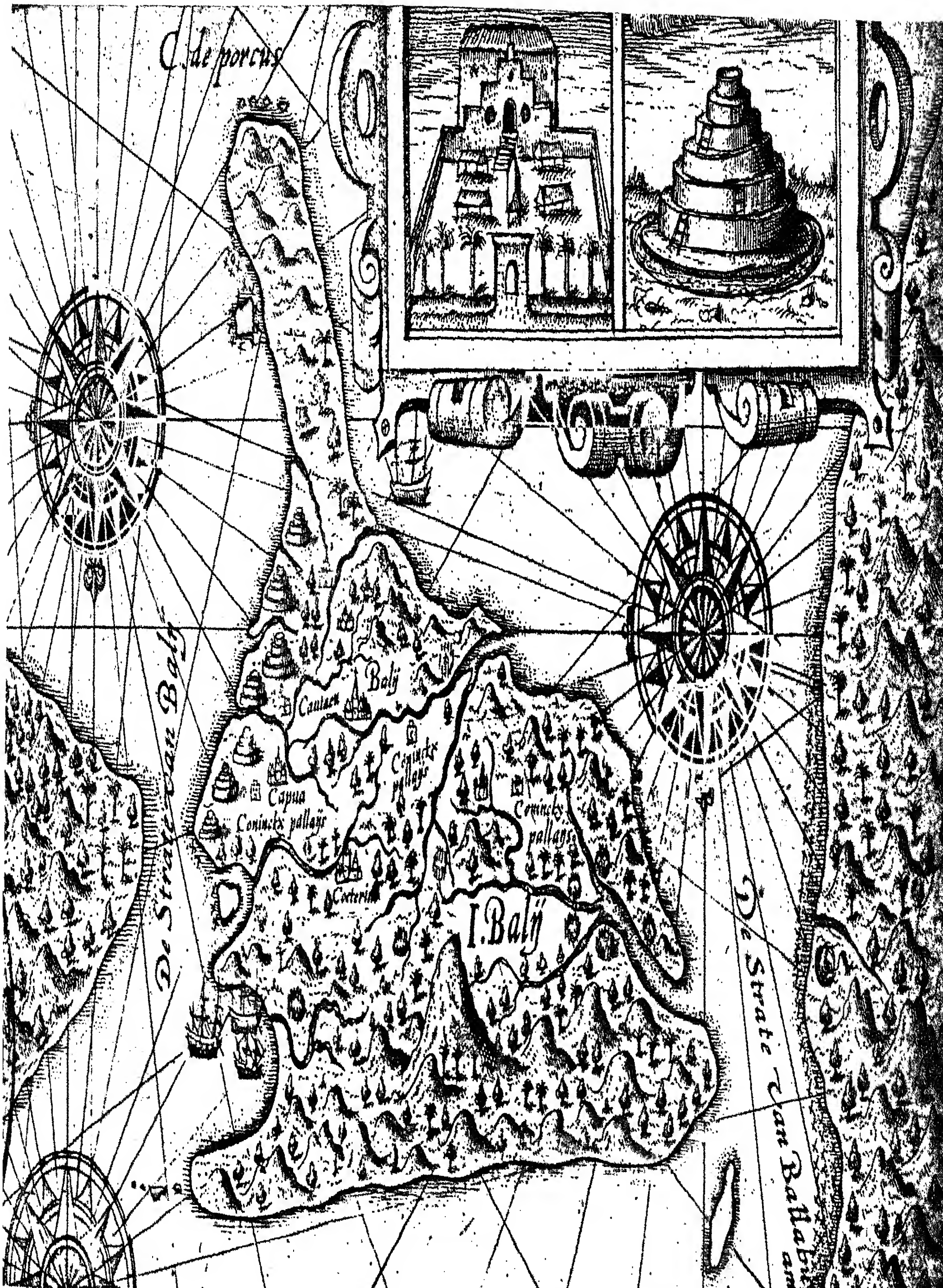


FIGURE 131. — AN EARLY DUTCH MAP OF BALI. — From "De eerste Schipvaerd der Hollandsche Natie naer Oost-Indien. . . ." *in* "Begin ende Voortgangh van de Vereenighde Nederlantsche Geoctroyeerde Oost-Indische Compagnie" (1646). — *Courtesy Arnold Arboretum of Harvard University.*

**Rummelen** (F. van), Institute of Soils, General Agricultural Experiment Station, *Buitenzorg*.
**Rutten** (Dr. M.), Geologist, Dept. of Mines, *Buitenzorg*.

**Sadarsan** (Raden), Lecturer, Graduate School of Agriculture, *Buitenzorg*.
**Salm** (Ir. J.), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Saltet** (G. H.), Secretary and Librarian, Medical College, *Batavia*.
**Salverda** (Ir. Z.) (1939), Forester, Parengan Forest, *Bodjonegoro*.
**Samil**, Govt. Veterinarian, Govt. Veterinary Service (Lampoeng District), *Telokbetoeng*.
**Sandbergen** (A. J. D.), Supt., Sugar Factory Poerwoasri, *Kediri*.
**Sanden** (P. G. van der) (1936), Tempor. Extension Agronomist (Celebes).
**Sandick** (Ir. F. H. van) (1938), Extension Agronomist (Central Java).
**Santen** (B. J. van), Sugar Factory Poerwoasri, *Kediri*.
**Sapoean Sastrosatomo**, Physician, *Tasikmalaja*.
**Sardjito** (Dr.) (1931), Chief Govt. Physician, Laboratory of the Govt. Medical Service, *Semarang*.
**Sardjono** (Ir. M.) (1938), Div. of Wood Information and Propaganda, Govt. Forest Research Institute, *Buitenzorg*.
**Saubert** (Dr. L. G. G.), Agronomist, Experiment Station of the Association of Sumatra Rubber Growers, *Medan*.
**Saveur** (Ir. G.) (1939), Forester, C. Preanger Forests, *Bandoeng*.
**Savornin Lohman** (Jhr. Mr. A. F. de) (1939), Govt. Veterinary Service, Dept. of Economic Affairs, *Batavia*.
**Schaaf** (A. van der) (1936), Bacteriologist, Veterinary Research Institute, *Buitenzorg*.
**Schaafsma** (Ir. N. D. R.) (1932, 1938), Scientific Assistant, Govt. Medical Service, *Bandoeng*.
**Schaar** (Dr. P. J. van der) (1939), Lecturer, College for Indonesian Physicians, *Soerabaja*.
**Schaeffer** (Dr. C. O.) (1935), Chemist-Bacteriologist, Govt. Medical Service, and Institute of Technology, *Bandoeng*.
**Schagen** (Ir. H. van), Horticulturist, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Scheepe** (P. L.), Physician, *Palembang*.
**Scheer** (Ir. J. van der), Central Technological Laboratories, *Batavia*.
**Scheffelaar** (Ir.), Institute of Soils, General Agricultural Experiment Station, *Buitenzorg*.
**Scheltema** (Dr. A. M. P. A.) (1939), C. Statistical Office, *Batavia*.
**Schepel** (Ir. K.), Mechanical Engineer, Java Sugar Experiment Station, *Pasoeroean*.
**Schepers** (Ir. L.), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Schermerhorn** (Ir. E. J. G.), Director, Java Sugar Experiment Station, *Pasoeroean*.
**Schijfsma** (Ir. J. H.), Director, Public Works, *Cheribon*.
**Schijveschuurder** (W.), Physician, *Kotaradja*.
**Schilden** (Ir. B. van der), Mining Engineer, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Schimmel-Schaafsma** (Mrs. W.), Treasurer, Neth. Indies Ornithological Society, *Batavia*.
**Schimmelpfennig** (H. K. F.) (1925, 1935), Forester, Indramajoe Forest, *Plossokerep*.
**Schiphorst** (S. P.), Chief Physician (Bantam), *Serang*.
**Schiphuis** (K.) (1921, 1928, 1937), Director, Ceramics Research Station, *Bandoeng*.
**Schippers** (W. W.), Supt., Sugar Factory Trangkil, *Pati*.
**Schmöle** (Ir. J. F.), Agronomist, Experiment Station of the Association of Sumatra Rubber Growers, *Medan*.
**Schneider** (J.), Supt., Sugar Factory Gesiekan, *Jokjakarta*.
**Schnepper** (W. C. R.) (1928, 1935), Chief Forester, West Preanger Forests, *Soekaboemi*.
**Schoemaker** (Ir. R. L. A.), Professor of Architecture, Institute of Technology, *Bandoeng*.
**Schoenmaker** (Ir. W. H.), Chemist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Schokkenkamp** (Ir. J.), Topographical Survey, *Weltevreden*.
**Schol** (T. C.) (1938), Director, Govt. Veterinary Service, *Batavia*.
**Scholte** (Drs. G. W. A.), Office of the Census, *Batavia*.
**Scholten** (Ir. G. H.), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Scholtens** (Ir. K.), Divisional Head, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Schooneveldt** (Ir. J. C. van), Agronomist, Experiment Station West Java, *Buitenzorg*.
**Schoorel** (Ir. A. F.), Agronomist, Experiment Station West Java, *Buitenzorg*.
**Schoorel** (C. W.) (1939), Lecturer, College for Indonesian Physicians, *Soerabaja*.
**Schoorel** (Ir. G. F.), Chemist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Schoorel** (P. M.), Seismologist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia*.
**Schophuijs** (Dr. H. J.), Extension Agronomist (Prov. of West Java), Dept. of Economic Affairs, *Batavia*.
**Schophuijs** (Ir. W. J. H.) (1931, 1937), Chief Forester, *Semarang*.
**Schot** (Ir. A. G. G.), Mining Engineer, Shell Oil Co (B.P.M.), % Head Office, *Batavia*.
**Schotsman** (Dr. J. G. W.), Director, School for Farriers *Tjimahi*.
**Schoute** (Ir. P. H.), Mining Engineer, Shell Oil Co., (B.P.M.), % Head Office, *Batavia*.
**Schouwenburg** (Dr. Ir. K. L. van), Botanist and Chemist, and Secr. "Chemische Kring Malang," *Malang*.
**Schregardus** (Dr. M. W. F.) (1937), Research Associate, R. Meteorological Observatory, *Batavia*.
**Schreinemachers** (Dr. H. H.), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Schreuder** (Ir. E. J.) (1939), Chief Forester, Sumatra East Coast Forests, *Pematang-Siantar*.
**Schreuder** (Ir. H. H. Th.) (1935), Forester, *Tandjoeng Balei* (Sumatra).
**Schreuder** (J. L. J.) (1938), Head, Licenses Div. of the Rubber Restriction Board, *Batavia*.
**Schreuder** (W. H. E.) (1939), Temporary Director, Graduate School of Agriculture, *Buitenzorg*.
**Schreven** (D. A. van), Tobacco Experiment Station, *Klaten*.
**Schrieke** (Ir. O. B.), Experiment Station of the Association of Sumatra Rubber Growers, *Medan*.
**Schroeff** (Dr. J. P. van der), Physician, *Lho Seumaweh*.
**Schroo** (Ir. H.), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Schroots** (C. J.) (1918, 1932), Govt. Veterinarian, Govt. Veterinary Service, *Batavia*.
**Schuack** (H. J.), Technician, Experiment Station of the Klattensche Cultuurmij., *Klaten*.
**Schuitemaker** (Ir. B.) (1930, 1937), Extension Agronomist, Dept. of Economic Affairs, *Batavia*.
**Schuitemaker** (Ir. J. P.) (1929, 1935, 1937), Chief Forester, and Lecturer, Graduate School of Agriculture, *Buitenzorg*.
**Schurink** (Dr. A. J.), Botanist, *Batavia*.
**Schuster** (W.) (1928, 1935, 1939), Extension Ichthyologist (Fresh Water Fisheries), *Soerabaja*.
**Schuurman** (Dr. J. J.) (1938, 1939), Extension Ichthyologist of the Provincial Council of Central Java, *Semarang*.
**Schwab** (F.) (1928), Forester, West Preanger Forests, *Soekaboemi*.
**Schweizer** (Dr. J.), Director, Besoeki Experiment Station, *Djember*.
**Segond von Banchet** (Ir. A.), Engineer, Colonization Section, Div. of Waters, Dept. of Roads and Waters, *Bandoeng*.
**Seldam** (R. E. J. ten), Physician, *Bandoeng*.
**Sevensma** (Dr. P. H.), Assistant (Geological Cartography), Dept. of Mines, *Bandoeng*.
**Sewandono** (Ir. Mas) (1938), Chief Forester, Banjoewangi Forests, *Banjoewangi*.
**Seyffardt** (Ir. A. L. W.) (1936), Extension Agronomist for Atjeh, *Koetaradja*.
**Seyffers** (S. M.) (1930, 1938), Govt. Veterinarian, Govt. Veterinary Service, *Taroetoeng*.
**Sieburgh** (Ir. E.), Engineer, Hydraulics Section, Electric Power Div., Dept. of Roads and Waters, *Bandoeng*.
**Siegenbeek van Heukelom** (Dr. A.), Professor of Internal Diseases, Medical College, *Batavia*.
**Siethoff** (Mr. J. G. A. ten) (1935), Administration, Dept. of Economic Affairs, *Batavia*.
**Sieverts** (A.) (1938, 1939), Chief Forester, South Borneo Forests, *Bandjermasin*.
**Simons** (Dr. A. L.), Assistant (Geological Cartography), Dept. of Mines, *Bandoeng*.
**Simons** (Dr. L. H.), First Physician, Military Medical Service, *Bandoeng*.

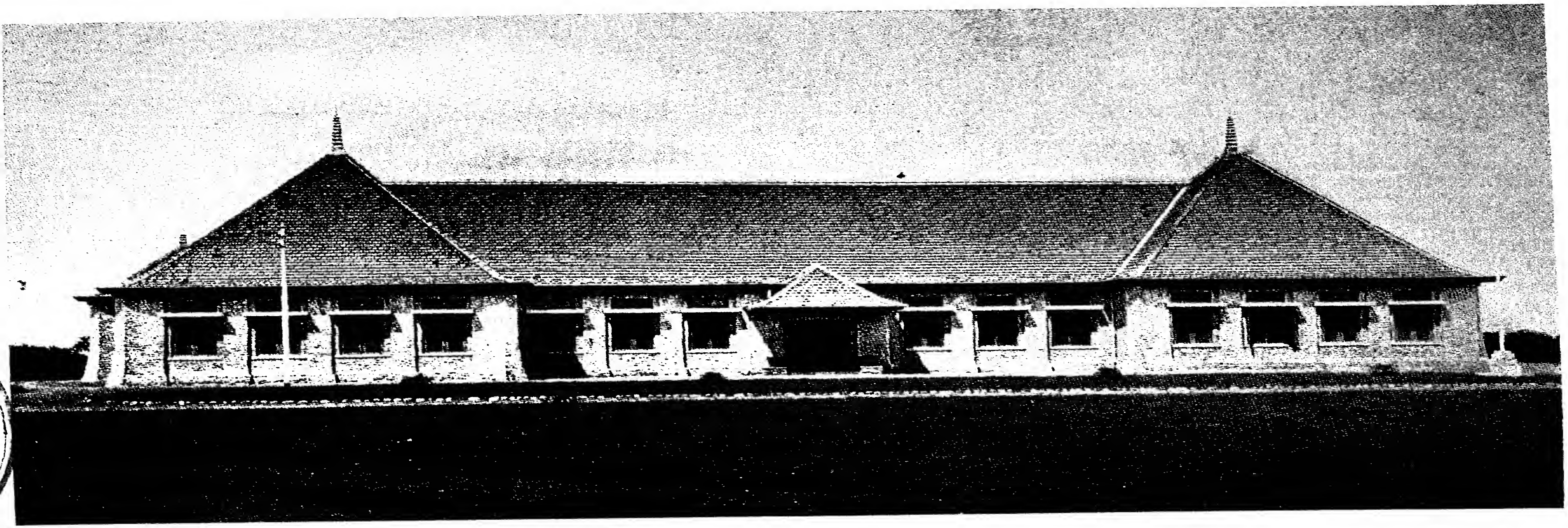

FIGURE 132. — ONE OF THE BUILDINGS OF THE EXPERIMENT STATION WEST JAVA, BUITENZORG (formerly the Tea Experiment Station).

**Simons** (Dr. **R. D. G. Ph.**), Dermatologist, *Batavia-C.*
**Sippel** (Ir. **J.**) (1931, 1936, 1939), Engineer, Central Purchasing Office, *Bandoeng.*
**Sitanala** (**J. B.**), Physician (Leprosy), *Semarang.*
**Sitter** (**A. de**), Director, Bosscha Astronomical Observatory, *Lembang.*
**Sittrop** (**E.**) (1938, 1939), Editor of Publications, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Sjamsoe**, Govt. Veterinarian, Govt. Veterinary Service, *Bandjermasin.*
**Slamet Soedibjo** (**R. M.**), Physician, *Batavia.*
**Sleen** (**N. van der**), Geologist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*
**Slis** (Ir. **J. J.**), Head, Electrical Dept., Refineries, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*
**Sloof** (Ir. **G.**), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Slooten** (Dr. **D. F. van**) (1931, 1936), Chief, Herbarium, Govt. Botanic Gardens, *Buitenzorg.*
**Slot** (Ir. **G. J.**), Engineer (Dredging Operations), Banka Tin Mines, *Banka.*
**Sluys** (**van der**), Asst. Hortulanus, Govt. Botanic Garden, *Buitenzorg.*
**Smeets** (**J. W.**) (1940), First Physician, Medical Service, Navy Yard, *Soerabaja.*
**Smit** (**C.**) (1939), Lecturer, College for Indonesian Physicians, *Soerabaja.*
**Smit** (**M. J.**), Director, Sugar Factory Zevenbergen.
**Smits** (**E.**), Physician, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Smitte** (**F. A. C.**), Office of the Census, *Batavia.*
**Smoor** (Ir. **P. J. C.**), Engineer (Dredging Operations), Banka Tin Mines, *Banka.*
**Snijders** (Ir. **W. J. J.**) (1939), Forester, Govt. Forest Service, *Semarang.*
**Snoep** (Ir. **W.**), Adviser, Messrs. Anemaet and Co., Ltd. *Soerabaja.*
**Sody** (**H. J. V.**) (1926, 1937), Mammalogist, and Lecturer in Biology, Graduate School of Agriculture, *Buitenzorg.*
**Soearto Sosrohadikoesomo** (Ir. Raden Ngabehi) (1938), Extension Agronomist (East Java).
**Soebiarto** (Ir.) (1928, 1935), Extension Agronomist (Prov. East Java).
**Soedjadi** (Raden **Ferd.**) (1931), Forester, Djombang Forest, *Djombang.*
**Soekarno** (Raden), Govt. Veterinarian for Bima, Govt. Veterinary Service, *Raba* (Soembawa).
**Soemardjo** (1939), Technician, Div. of Wood Information, Govt. Forest Research Institute, *Buitenzorg.*
**Soenarjo** (Ir. Mas), Engineer, Hydrological Laboratory, *Bandoeng.*
**Soenoto** (Raden), Archaeological Service, *Tegal.*
**Soepardi**, Institute of Soils, General Agricultural Experiment Station, *Buitenzorg.*
**Soepardi Prawirodipoero** (Raden Ir.) (1931, 1935), Chief, Batik Research Station, *Jogjakarta.*
**Soeparman**, Govt. Veterinarian for Lombok, Govt. Veterinary Service, *Mataram*, Lombok.
**Soeparwi** (Mas) (1932), Govt. Veterinarian for Koepang, Govt. Veterinary Service, *Koepang.*
**Soeradiradja** (Raden **A.**), Chief Forester, Govt. Forest Service, *Koeningan.*
**Soerasno** (Raden) (1935), Adviser, Dept. of Economic Affairs, *Batavia.*
**Soerjatin** (Raden) (1936), Lecturer, College for Indonesian Physicians, *Soerabaja.*
**Soesilo** (Raden) (1939), Inspector (Borneo), Govt. Medical Service, *Bandjermasin.*
**Soesman** (Ir. **A. L.**), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Soesman** (Ir. **F. J. H.**), Krebet Plantations, *Boeloelawang.*
**Soetarmo Hardjowasono** (Mas), Forester and Silviculturist, Govt. Forest Research Institute, *Buitenzorg.*
**Soetisno** (Raden), Govt. Veterinarian, Prov. Veterinary Service, *Malang.*
**Soetomo Tjokronegoro** (R. M. H.), Assistant, Medical College, *Batavia.*
**Soetopo** (Mas) (1939), Lecturer, College for Native Physicians, *Soerabaja.*
**Soetrisno**, Physician, *Blinjoe.*
**Soewadji Prawirohardjo**, Physician, *Samarinda.*
**Soewoso**, Veterinarian, Prov. Veterinary Service, *Madioen.*
**Sorgdrager** (**P.**), Lecturer of Pharmacy, Medical College, *Batavia.*
**Spaan** (Ir. **E.**), Safety Engineer, South Sumatra Oilfields, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*
**Spoelstra** (Ir. **H. J.**), Technologist, "N.V. Klattensche Cultuur Mij.", *Jokjakarta.*
**Sporry** (Ir. **J. R.**), Engineer, Hydraulics Section, Electric Power Div., Dept. of Roads and Waters, *Bandoeng.*
**Sprenger** (Ir. **J. J. L.**), Professor of Hydraulics and Soil Physics, Institute of Technology, *Bandoeng.*
**Spruit P. Pzn.** (Dr. **C.**), Geneticist, Cinchona Experiment Station, *Pengalengan.*
**Spruyt** (Dr. Ir. **J. P.**), Lecturer in Chemistry, Medical Colege, *Batavia.*
**Staalen** (Ir. **A. J. van**), Chief Engineer, Hydraulics Section, Dept. of Waters, Dept. of Roads and Waters, *Bandoeng.*
**Stadt Schuurman** (**E. J. van de**), *Pladjoe* near Palembang, Sumatra. — Worked on plancton.
**Staple** (**D. B. van**) (1934), Assistant, Textile Research Station, *Bandoeng.*
**Staveren** (Colonel **M. T. van**), Chief, Topographical Survey, *Batavia.*
**Staverman** (**G. J.**), Assistant, Medical College, *Batavia.*
**Steenbergen** (**F. van**) (1939), Agronomist, Section for Education and Publications, Div. of Agriculture, Dept. of Economic Affairs, *Buitenzorg.*
**Steenis** (Dr. **C. G. G. J. van**) (1931, 1934, 1936), Chief, Herbarium and Museum for Systematic Botany, Govt. Botanic Gardens, *Buitenzorg.*
**Stehn** (**Ch. E.**), Vulcanologist, Geological Museum, *Bandoeng.*
**Stenfert** (Ir. **W. D. P.**), Director, N. V. Nederl. Telegraaf Mij. "Radio-Holland," *Batavia.*
**Stephan** (Ir. **L. P.**) (1936), Engineer, Central Purchasing Office, *Bandoeng.*
**Steup** (Ir. **F. K. M.**) (1929, 1935), Chief Forester, Riouw Forests, *Tandjoengpinang.*
**Stoker** (**W. J.**), Physician (Malaria), *Medan.*
**Stolp** (Miss Dr. **A.**), Office of the Census, *Batavia.*
**Stoppelaar** (Ir. **L. P. de**), Asst., "Handelsvereeniging Amsterdam", *Soerabaja.*
**Stork** (Ir. **B. H.**), Chief Engineer (Tin processing), Banka Tin Mines, *Banka.*
**Stoutjesdijk** (Ir. **J. A. J. H.**) (1929, 1936), Chief Forester, Semarang Forest, *Semarang.*
**Straaten van Nes** (Ir. **C. B. van**), Agricultural Adviser, "Nederl. Handelsmij," *Batavia.*
**Straatman** (**J. A.**), Agronomist, Sugar Factory, *Modjoagoeng.*
**Straub** (**J.**) (1928, 1929, 1937), Extension Agronomist, *Cheribon.*
**Streef** (Dr. **G. M.**) (1936), Lecturer, College for Indonesian Physicians, *Soerabaja.*
**Stutterheim** (Dr. **W. F.**), Director, Archaeological Service and Museum, and Conservator, Archaeolog. Collections, Kon. Bataviaasch Genootschap van K. en W. *Batavia.*
**Supit** (**E. B.**) (1931), Forester, Bangka-Billiton Forests, *Pangkalpinang.*
**Swart** (Ir. **F.**)(1927), Chief Forester, Govt. Forest Service.
**Swens** (**R. F.**), Chief Cartographer, Geological Div., Dept. of Mines, *Bandoeng.*
**Syll** (Ir. **G. G. van**), Chemist, Shell Oil Co. (B.P.M.), % Head Office, *Batavia.*
**Szemian** (Ir. **J. M. K.**), Head, Laboratory of the Banka Tin Mines, *Pangkalpinang.*

**Tamboenan**, Institute for Agricultural Technology, Genera Agricultural Experiment Station, *Buitenzorg.*
**Tammes** (Dr. **P. M. L.**), Institute for Agricultural Technology, Gen. Agricultural Experiment Station, *Buitenzorg.*
**Tan** (Dr. **J. H.**), Office of the Census, *Batavia.*
**Tan Sin Houw** (Ir.), Adviser, Central Technological Labs., *Batavia.*
**Tan Sin Hok** (Dr. Ir.), Paleontologist, Dept. of Mines, *Bandoeng.*
**Taranskeen** (Ir. **D. W.**), Assistant (Hydraulics and Irrigation), Institute of Technology, *Bandoeng.*
**Tarenskeen** (Ir. **P.**) (1934, 1939), Adviser for Small Industries, Dept. of Economic Affairs, *Semarang.*
**Tekelenburg** (Dr. **P.**), Surgeon, Head Medical Dept., Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong.*

FIGURE 133. — PRIMEVAL FOREST ALONG THE TJITARUM IN WEST JAVA: "Nemus intactum e regione artocarpearum circa fluvium Tji-tarum," (Tab. 38) by PAYEN (lithographed by LAUTERS) from BLUME's *Rumphia* (1835 *seq.*).

**Teko Soemodiwirjo** (Ir.) (1928, 1935, 1936), Extension Agronomist, Dept. of Economic Affairs, *Batavia*.
**Tellings** (J. A.), Physician, *Langsa*.
**Tergast** (Ir. G. C. W. Ch.) (1928, 1938), Extension Agronomist for Celebes, *Makassar*.
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**Verboeket** (Mr. K. F. J.), Lecturer, Graduate School of Agriculture, *Buitenzorg*.
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**Verhoeven** (Dr. F. R. J.) (1937), Keeper of the Government Archives, *Batavia*.
**Verhoog** (Ir. J. M.), Institute of Soils, Gen. Agricultural Experiment Station, *Buitenzorg*.
**Verkuyl** (Ir. A. H.) (1939), Forester, Govt. Forest Service, *Soerabaja*.
**Vermaat** (Ir. J. G.), Agronomist, Experiment Station West Java, *Buitenzorg*.
**Vermast** (E. Th.), Head, Radiotechnical Service, Dept. of the Interior, *Bandoeng*.
**Vermeulen** (Dr. J. Th.) (1939), Government Archives, *Batavia*.
**Vermunt** (Dr. L. W. J.), Geologist, Standard Oil Co. (Ned.-Ind. Kolon. Petr. Mij.), *Soengei-Gerong*.
**Verschoor** (Ir. A. M.) (1939), Govt. Medical Service, *Batavia* (?).
**Verschuer** (Baron Ir. F. B. van) (1938), Chief Forester, Djombang Forest, *Djombang*.
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**Versteeg** (Ir. C.) (1929, 1936), Chief Forester, Poerwakarta Forest, *Poerwakarta*.
**Versteegh** (Ir. B. A. J.) (1938), Forester, Banjoemas Forests, *Poerwokerto*.
**Versteegh** (Ch.), Assistant, Govt. Forest Research Institute, *Buitenzorg*.
**Versteegh** (Ir. F.) (1937), Forester for C. Sumatra, Govt. Forest Service, *Fort de Kock*.
**Vertregt** (M.), Supt., Sugar Factory Minggiran, *Kediri*.
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**Vincent** (J. A.) (1926, 1936), Chief Forester, East Celebes Forests, *Raha*.
**Vis** (M. D. Th.), Chief Inspector of Mines, Dept. of Mines, *Bandoeng*.
[**Visman** (Dr. F. H.), late Member, Council of the Netherlands Indies and President, Committee for the Promotion of Scientific Research in the Netherlands Indies, at present Member, Board for the Netherlands Indies, Surinam and Curaçao, *New York City*.]
**Visser** (C. A. de) (1921, 1937), Govt. Veterinarian, Govt. Veterinary Service, *Jogjakarta*.

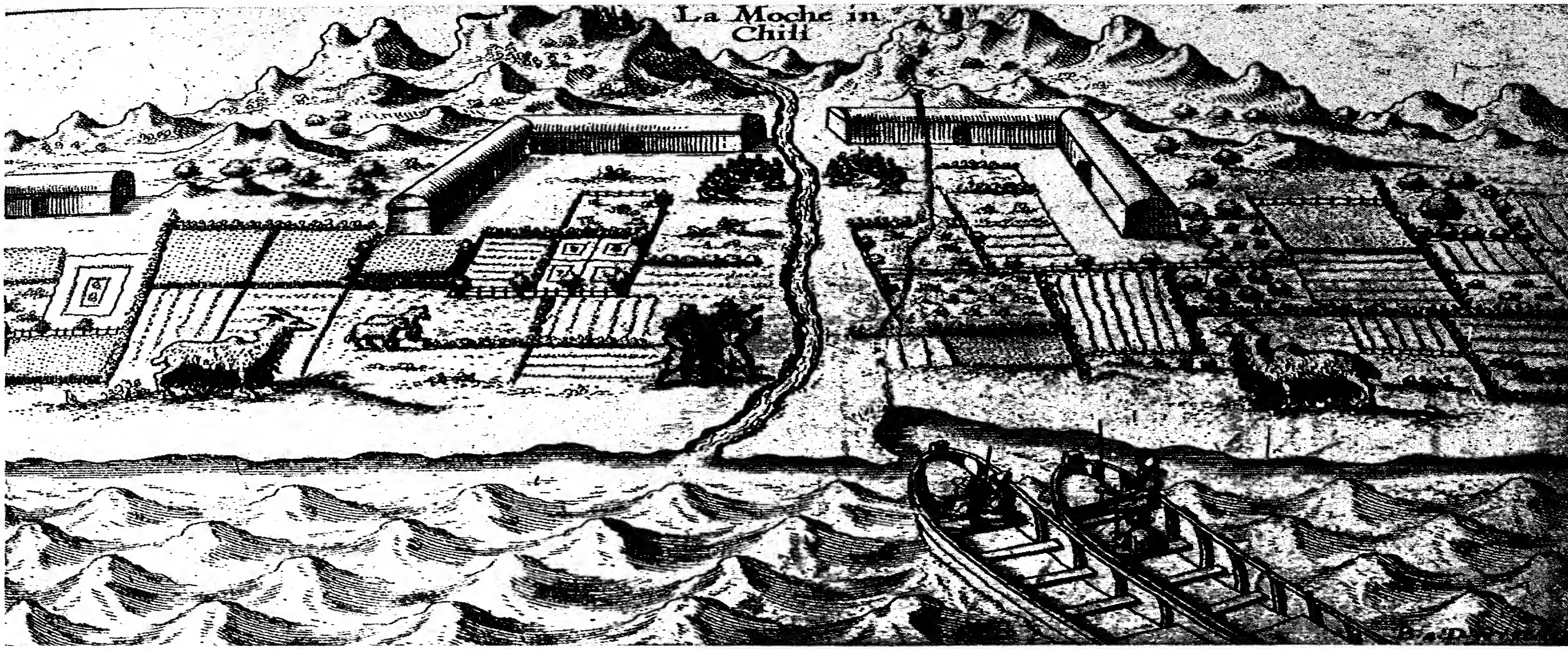


FIGURE 134. — A GROUP OF DUTCH SAILORS AND MERCHANTS IN CHILE (1600) ON THEIR WAY TO THE EAST INDIES, from "Beschrijvinge van de Schipvaerd by de Hollanders ghedaen onder 't beleydt ende Generaelschap van OLIVIER VAN NOORT, door de Straet ofte Engte van Magallanes, ende voorts de gantsche Kloot des Aertbodems om" *in* "Begin ende Voortgangh van de Vereenighde Nederlantsche Geoctroyeerde Oost-Indische Compagnie" (1646). — Around 1600 several Dutch expeditions explored the route via the West Indies, Street of Magallanes and the Pacific Ocean to the East Indies "ende alomme, waer 't doenlyck te traffiqueren" (trading wherever possible). Many interesting accounts report about these early voyages, several of them of considerable historical importance. — *Courtesy Arnold Arboretum of Harvard University.*

**Visser Smits** (Dr. D. de), Teacher of Biology, *Batavia*.
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**Vlies** (Ir. A. P. van der) (1936), Forester, Menado Forests, *Menado*.
**Vlugter** (Ir. H.), Director, Hydrological Laboratory, *Bandoeng*.
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# SERTA MALESIANA

## — *Short articles — Reports — Notes — Reviews, etc.* —

JAMES F. ENGERS: **The Board for the Netherlands Indies, Surinam and Curaçao:** — After the occupation of the greater part of the Netherlands Indies in the spring of 1942, three principal organs of the Government of the Indies were established on foreign soil. The Lt. Governor-General was shortly appointed Minister for the Colonies in the Netherlands Cabinet, then residing in London, and around him the Government of the Netherlands Indies was organized. In Melbourne the Netherlands Indies Commission for Australia and New Zealand was established, which eventually combined with the principal elements of the London setup became the Government of the Netherlands Indies in Brisbane under Dr. VAN MOOK as Lt. Governor-General who had resigned as Minister for the Colonies.

The third organ of the Netherlands East Indies administration was established in the United States, the Board for the Netherlands Indies, Surinam and Curaçao with offices in New York and Washington. It is with the latter that we are concerned here.

The need for a Netherlands East Indies representation in the United States during the war arose logically because of the prominent part which the United States was taking in the affairs of the war, and would most likely in the affairs of reconstruction.

At about the same time the Netherlands Government was planning to establish an organization for the promotion of the economic interests of the Netherlands in the United States. It was therefore decided to combine both projects.

By Royal Decree of August 28, 1942, No. 1, a Mission for the Economic, Financial and Shipping Affairs of the Kingdom was established in the United States, composed of a Netherlands Board and a Board for the Netherlands Indies, Surinam and Curaçao. The Mission was placed under the general supervision of Her Majesty's Ambassador in Washington.

By this same Decree, the Board for the Netherlands Indies, Surinam and Curaçao was formally entrusted to deal with all problems relative to the economic and financial affairs of these territories in the Western Hemisphere, according to directives given by the Minister for the Colonies.

The work of the Board for the Netherlands Indies, Surinam and Curaçao can best be characterized as serving the war effort of the United Nations, and especially of the Netherlands Indies.

The *Division of Documentation and Information* has as its task to supply all information regarding the Netherlands Indies to American public and private organizations as well as to individuals. It collects data about the situation in the occupied countries of the Far East and has a large clipping department. Until the end of the war it had its own radio department broadcasting to the Netherlands East Indies from the Pacific Coast. It has given assistance to the Office of War Information and the radio services.

The *Division for Industrial Reconstruction* has been entrusted with the task to prepare the reconstruction of the Indies industries. It prepared the SITSEN-plan for relief and reconstruction of the Netherlands Indies industries, railroads, communications, shipping and fishing, named after its originator, the late P. H. W. SITSEN. This called for an emergency import program of 500,000 tons through a combination of private enterprise and government supervision. The rehabilitation of the tin and oil industries remained in the hands of the private corporations, under broad supervision by the division. Large purchases have been made for relief and rehabilitation of the Indies through the Netherlands Purchasing Commission.

The *Division for Agricultural Reconstruction* has prepared for the rehabilitation of the export agricultures such as rubber, tea, and many others. For this purpose competent technical personnel has been engaged to be sent to the liberated parts of the archipelago at a moment's notice, and the necessary materiel was purchased in the United States through the Netherlands Purchasing Commission.

Both reconstruction departments have to acknowledge a great deal of friendly assistance from American Government agencies and private enterprise.

While both departments had based their calculations on a fight to the finish by the enemy, the speedy surrender of the Japanese after victory in Europe has given great hope that a return to normal trade and export conditions in the Netherlands East Indies can be expected at an early date.

The *Division of Finance* has represented the Government of the Netherlands Indies in the United States in the field of finance. It has conducted discussions with Treasury officials as well as with private American banks regarding financial assistance to the Indies.

Notes about various other activities of the Board will be found below, the activities of the *Central Depository Library for the Netherlands Indies* may be of special interest to the readers of this volume.

The original composition of the Board was as follows:

Dr. G. H. C. HART — *Chairman*,
E. C. ZIMMERMAN — *Vice-Chairman*,
Dr. P. HONIG,
Dr. P. H. W. SITSEN.

In November, 1942, Raden LOEKMAN DJAJADININGRAT became the fifth Member of the Board while during 1943 Dr. J. C. BRONS also served as Member of the Board. Messrs. HART (*see* p. 470), DJAJADININGRAT and SITSEN (*see* p. 469) have since passed away; Dr. BRONS was appointed Acting Governor of Surinam at the end of 1943, and retired from the Board.

At present, composition of the Board is as follows:

Dr. D. CRENA DE JONGH — *Chairman*,
E. C. ZIMMERMAN — *Vice-Chairman*,
F. C. ARONSTEIN,
Dr. P. HONIG,
Dr. F. H. VISMAN,
G. J. J. WOUTERS.

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BOARD FOR THE NETHERLANDS INDIES,
SURINAM AND CURAÇAO,
NEW YORK CITY.

PIETER HONIG and FRANS VERDOORN: **The Central Depository Library for the Netherlands Indies in New York City:** — At the time of the Japanese invasion there was in the Netherlands Indies a large number of libraries, ranging in size and importance from a few very large libraries, like those of the College of Medicine, the Library of the Department of Economic Affairs, and the Library of the Royal Batavian Society of Arts and Sciences, to the small village libraries for the Indonesian population. The large special libraries were subscribing to practically all foreign journals in their field and were acquiring almost any foreign technical book which seemed of some importance or interest. As a result, the library resources of the Netherlands Indies were considerable; it has often been said that they were unsurpassed in any tropical country.

A few months after the invasion of the Netherlands Indies, the *Board for the Netherlands Indies Surinam and Curaçao* was established in the U.S.A., chiefly to prepare for the economic reconstruction of the Netherlands Indies. Knowing of the extraordinary difficulties [1] which confronted libraries after the First World War when they tried to complete their sets of scientific and technical periodicals (serious gaps still exist today in North American and British holdings of foreign materials produced during the First World War), this Board at an early date formulated a programme for the acquisition [2] of periodicals and books for the Netherlands Indies. According to this programme, not all but the majority of the important periodicals, pamphlets, and books which would have been received in the Netherlands Indies in normal times have been acquired by the Board and stored in New York (and elsewhere) [3] until they can be shipped to the Netherlands Indies.

Early in 1943 the first orders covering the continuation of 340 periodicals in 753 copies were issued. The first orders were made out by VERDOORN, Botanical Adviser to the Board for the Netherlands Indies, Surinam and Curaçao, after some study in Washington libraries, and included particularly periodicals for the Department of Economic Affairs and the principal experiment station libraries. It appeared that no copies of certain Latin American and Russian periodicals had hitherto been available in the Netherlands Indies; some of the most important were added to our lists. After a time, this work became so extensive and complicated that the Board authorized VERDOORN to organize a *Central Depository Library for the Netherlands Indies*. This library was established in July 1943 with an office at 441 Lexington Avenue, New York City, and Miss E. VAN AALTEN, a Netherlands-born professional librarian, was put in charge of it. Periodicals in many fields were now added. The library was especially fortunate in having the advice [4] of Dr. C. BOSSCHIETER (Chemistry), Prof. Dr. BART J. BOK (Astronomy), Ir. ALEX L. TER BRAAKE (Mineralogy), Major Ir. S. VAN BRAAM (Engineering), Ir. G. OTTEN (Engineering), Prof. Dr. I. SNAPPER (Medicine), while Messrs. Dr. P. HONIG, Dr. GRENA DE JONGH, Raden L. DJAJADININGRAT, Dr. F. H. VISMAN, H. BOS, H. DE VOOGD, Dr. J. VON BEUSEKOM and J. F. ENGERS gave valuable advice concerning the acquisition of general periodicals, material dealing with the humaniora, etc.

Towards the end of 1943, orders covering the majority of the more important periodicals [5]

[1] The *American Library Association*, through its *Committee to Aid Libraries in War Areas*, has been collecting periodicals for distribution to libraries of war torn areas. To that end, they have solicited and received the assistance of publishers who are furnishing lists of the European and Asiatic institutions which, before the war, had subscriptions to their publications.

It is not anticipated that there will be enough copies of the periodicals for all former subscribers, and in making selection of what institutions will receive available copies, consideration is being given to (*a*) geographic distribution, so that important research centers are considered first and material will be available to the greatest number of scholars interested in a particular subject; and (*b*) the size and importance of an institution's or a library's usual clientele and its willingness to allow its use by others who need access as well as its post-war status and plans.

For this distribution, the A.L.A. has drawn up a tentative list of priority by country. According to this list, the 24th copy of a given periodical would reach the Netherlands East Indies. If this fact is taken in conjunction with the fact that, on the A.L.A.'s report dated Dec. 31, 1944, of the 359 periodicals held for distribution in war areas, approximately only one-half have been obtained in more than 20 copies, it can readily be seen that the Netherlands East Indies should do everything possible to help itself obtain current subscriptions and back issues at least as far as 1942.

[2] Efforts of a similar nature have been undertaken by, or on behalf of the governments of Denmark, Sweden, Norway, China, Poland, Belgium, etc.

[3] The Netherlands Indies have been happy to have on the Board of the Netherlands Indies a number of men who perfectly understand the importance of a good acquisition programme. From discussions and correspondence with advisers of certain other temporarily occupied countries, it appears that not all governments were so lucky in having such far-seeing officials. In certain cases the advisers, who hold themselves responsible for the acquisition programme, complain that they meet daily with men in high and low positions who do not understand the need of giving so much attention during a war to the acquisition of periodicals and books, mostly "material which has no bearing whatsoever on the conduct of war." Once, when asked to do so, VERDOORN formulated the following advice for an official of an allied, occupied country: —

(*a*) Be prepared to explain in detail, day after day, that all progress is based on research and all research to a large extent on the study of literature; explain also, when necessary, that war is a form of politics and that politics, again, is applied philosophy and that all these things have a strong bearing on recent progress and advances in many fields and in many parts of the world.

(*b*) Emphasize that there is a daily increasing paper shortage and severe paper rationing all over the world. All publishers print at present fewer copies than in normal times. There will be quite a struggle to get hold of the little that may be left after the war.

(*c*) Explain that the ratio of books going to libraries and to individuals is changing from generation to generation in such a way that less and less material is going into private collections (which some day will come again on the market) and more and more to libraries (which, as a rule, keep what they acquire).

(*d*) Make clear that not even one per cent of material in periodicals is ever reprinted and less than ten per cent of books and pamphlets, and that the books which are never reprinted are very often of more scientific value than the textbooks which are reprinted.

(*e*) Make clear that photostats and microfilm apparatus are an aid to library work but not in any way a substitute for libraries.

[4] Though this was considered at one time, the Central Depository Library for the Netherlands Indies has never had the assistance of a formal "Advisory Committee" such as that organized by the governments of some other countries. After decisions concerning the periodicals to be subscribed to had been made, the duty of these "Advisory Committees" has been mostly to give moral support or to obtain funds, for which there has been no need in our case (*cf.* above).

[5] VERDOORN and Miss VAN AALTEN made lists of the principal periodicals in the fields which it was considered

formerly received in the Netherlands Indies had been placed. This material, as far as it concerns North American periodicals, is being stored and packed by Messrs. G. E. Stechert, at 31 East 10th Street, New York City. The packages are numbered and the title and number entered in a card index. The Central Depository Library is acquiring its periodicals in 1–6 sets. About ten per cent of the acquisitions are received without charge. Many hundred books have been acquired, of which part have been deposited in a hand- and reference library in the Offices of the Board for the Netherlands Indies, Surinam and Curaçao, at 10 Rockefeller Plaza, New York City, and part Stechert is packing for shipment to the Netherlands Indies. Also, currently many technical books have been shipped to the Economic Reconstruction Section of the Neth. Indies Department of Economic Affairs in Australia, as well as many medical books to Dr. BONNE of the Neth. Indies Medical Mission, also in Australia. These will eventually reach the Netherlands Indies.

Furthermore, the library is subscribing to various periodicals of an economic and technical nature which are being sent monthly to the Neth. Indies Department of Economic Affairs, Australia.

Close coöperation was established with the *Netherlands Govt. Commission for Scientific Documentation* (which is responsible for the official acquisition programme on behalf of the Netherlands) in London. Material ordered by this organization in the Americas is received, sorted and stored by us at 235 E. 38th Street, New York City. VERDOORN, and later Miss VAN AALTEN and several advisers, helped select American periodicals for the Netherlands Govt. Commission for Scientific Documentation. This commission, on the other hand, undertook to store in London the material ordered for the Netherlands Indies in the United Kingdom, where, with the kind help of the energetic secretary of the Netherlands Govt. Commission for Scientific Documentation, Ir. A. F. H. BLAAUW, it has been put in Unilever House, London, E. C. 4, awaiting shipment to the Netherlands Indies at the appropriate time. This Committee, working in close coöperation with the *Conference of Allied Ministers of Education, Books and Periodicals Commission*,[6] has also ordered a large number of books on behalf of the Netherlands Indies libraries.

For the benefit of those interested in work of this kind, we should like to state that, unless it is possible to have the help of a reliable agent, it is desirable to store all publications as close to the office of the Central Depository Library as possible in order that not too much time will be lost in commuting between the office and the storage rooms. The incoming books, periodicals and journals have to be checked and entered in an accession book just as in any other library. The war situation makes the task of persons responsible for this work somewhat difficult; many numbers, indices, and titles get lost in some way or another and have to be replaced as quickly as possible.

During the war, most books are being published in smaller quantities than normally. Experience has shown that they sell out very fast (especially in the British Empire). Lists of new books must be watched carefully and reported to the responsible advisers. In several instances recent British books of the international monograph type sold out within a few months. We endeavour to distinguish between textbooks and semi-popular books which are likely to be reprinted or to be superseded by other books, on the one hand, and books, memoirs and monographs which contain original material (of the kind we find in a scientific periodical) and, as experience shows, are hardly ever reprinted, though *e.g.* a chemical memoir is more likely to appear again than a zoological memoir, on the other hand.

Books, then, have been ordered by our Library in fair number, though on a much more restricted scale than the periodicals. Pamphlets[7] of historical importance were also acquired, especially by J. F. ENGERS (general) and by W. J. LUGARD (agriculture) and F. VERDOORN (material for the Botanic Gardens at Buitenzorg).

Though lists of continental periodicals of special importance have been made, they have not been purchased, inasmuch as we gathered from reports received by the Board for the Netherlands Indies, Surinam and Curaçao, that they were being collected for the Netherlands Indies by the Colonial Institute of Amsterdam.

In June, 1944, Miss VAN AALTEN resigned, after being appointed to the Netherlands Studies Unit of the Library of Congress in Washington, D.C. She was succeeded by Miss K. F. HARTOGH, who, upon joining the "Nederlandsch Vrouwen Hulp Corps," was followed by Mrs. C. DE GROOT, formerly of the Netherlands Exchange Control, who lived in the Netherlands East Indies from 1939 till 1941. She had the assistance of Miss H. RUBIN, formerly of the New York Public Library. The help rendered by Mr. J. A. MERSCH should also be mentioned.

At one time VERDOORN and later Miss VAN AALTEN made considerable efforts to receive exchange materials formerly sent to the Netherlands Indies. A number of large institutions (*e.g.*, the U. S. Department of Agriculture) report that they are holding all material on behalf of the Netherlands Indies and, in certain other cases, institutions (especially a few in Brazil) expressed their confidence in the future by offering material not formerly sent to the Netherlands Indies for possible later exchange. On the whole, these efforts were not too successful. It should be clearly understood that the Netherlands In-

necessary to cover (*e.g.* medicine, chemistry, engineering, etc.). With the help of our advisers these lists were checked with various standard bibliographies (*e.g.*, ULRICH). In certain cases the standard bibliographies were not too suitable for a tropical country.

Another problem which presents itself is the surprising number of new, often ephemeral periodicals which continue to appear all over the world in spite of war difficulties. They are often of interest to specialized libraries and need constant watching.

[6] This Commission issued a very handy monthly list of new scientific and technical books which was prepared in such a way that it could be used as a basic order list.

[7] There appear in time of peace and war numerous small, paper-bound booklets of all kinds, especially on "timely" subjects. Individually they are not always too important, and are, therefore, often overlooked. In a large library, however, these pamphlets in a given field must be present as completely as possible. The N. E. I., *e.g.*, will want copies of all pamphlets dealing in some way or other with Japan, warfare in the tropics, etc. The British and American trade and library journals, as well as the "Pan-American Bookshelf" and certain South American trade journals, have been watched constantly for titles of this nature. They can be ordered, as a rule, without instructions from the advisers, for only small sums are involved and they have to be gathered completely and quickly.

dies received much less material on an exchange basis than, *e.g.*, the Netherlands. In this connection it may be of interest to give a list of the principal scientific periodicals published in the Netherlands Indies as of November 1941 (*sec.* Natuurwet. Tijdschr. Ned. Indië 101, 11, 1941): —

*Annals of the Botanic Gardens, Buitenzorg.*
*Archief voor de Suikerindustrie.*
*Archief voor de Koffiecultuur.*
*Archief voor de Rubbercultuur.*
*Archief voor de Theecultuur.*
*De Bergcultures.*
*Bulletin of the Botanic Gardens, Buitenzorg.*
*Bulletin van het Deli Proefstation.*
*Bulletin of the Netherlands Indian Volcanological Survey.*
*Entomologische Mededeelingen v. Ned. Indië.*
*Geneeskundig Tijdschrift v. Ned. Indië.*
*De Indische Jager.*
*De Ingenieur in Nederlandsch Indië.*
*Jaarboek v. d. Topographischen Dienst.*
*Jaarboek v. d. Dienst van den Mijnbouw.*
*Landbouw.*
*Mededeelingen v. h. Algemeen Proefstation voor den Landbouw.*
*Mededeelingen v. d. Dienst v. d. Volksgezondheid.*
*Mededeelingen v. h. Deli Proefstation.*
*Mededeelingen v. h. Proefstation v. d. Vorstenlandsche Tabak.*
*Ned. Indische Diergeneeskundige Bladen.*
*Ned. Indisch Pharmaceutisch Tijdschrift.*
*Ned. Indische Geographische Mededeelingen.*
*Tectona.*
*Treubia.*
*De Tropische Natuur.*
*Verhandelingen v. h. Kon. Magn. en Meteor. Observatorium.*
*Verslag v. d. Vereeniging v. Proefstationspersoneel.*
*Verslag van het Ned. Indisch Natuurwetenschappelijk Congres.*
*Verslagen van de Ned. Indische Vereeniging tot Natuurbescherming.*
*Wetenschappelijke Mededeelingen van den Dienst v. d. Mijnbouw.*

Little is known of the influence of the war on the library resources [8] of the Netherlands Indies. One hopes that the Batavia-Buitenzorg and Soerabaja areas have escaped the fate of Manila, where most of the libraries and museums, containing irreplaceable collections, the fruits of forty years of work, have been destroyed. As soon as reports to the contrary are received it will be the task of our Central Depository Library to care not only for the publications issued since the Indies lost their freedom, but also for earlier publications, primarily (*1*) important hand and reference books, and (*2*) sets of the more important periodicals. Material of this kind, however, is at present already difficult to obtain. A little relief is offered by certain modern offset reprint editions, but this cannot fill more than a fraction of one per cent of the needs, in case larger libraries are lost.

*Note:* — **Individuals or institutions who have scientific books, periodicals, pamphlets, photographs, and memorabilia which they would like to give to the Central Depository Library for transmittal in due time to an appropriate Institution should communicate with: "The Librarian,**

[8] The following historical notes have been kindly prepared by Miss VAN AALTEN.

The evolution of the library situation in the Netherlands East Indies can be divided in three periods: —

*Until 1816.* — In 1778 the first library of importance — still the largest general scholarly library in the East Indies — was founded: the library of the "Kon. Bataviaasch Genootschap voor Kunsten en Wetenschappen" in Batavia (for a general historical account of this society, *see* F. D. K. BOSCH 1938, Bull. Kol. Inst. Amsterdam 1:116–124). The humanities, geography and anthropology have, from the beginning, been well represented. A survey of the first period of the library may be found in the 1936 Yearbook of the Society (p. 235–241). The library of the College of Law, classified by a system prepared by Prof. J. VAN KAN, has been housed in the premises of this Society since 1924. This library has ca. 300,000 books. The manuscript collection is important, too; a description of the Malayan, Javanese and Kawi MSS. may be found in the supplementary catalogue of 1872 by A. B. COHEN STUART. In 1940 they published a printed catalogue on the subject of history, which is in the Library of Congress. In 1938 a mimeographed catalogue on human geography and anthropology was published; this is available in the Library of the Netherlands Information Bureau.

The society's library also endeavours to compile a central catalogue comprising all book titles, with the exception of the natural sciences, from the libraries in the East Indies.

*The period 1816–1910.* — In this period the different departmental, municipal and other governmental libraries for the use of government employees, military men and educational institutions were founded. The different agricultural experiment stations and "'s Lands Plantentuin" assembled also sizable libraries in their fields.

The following professional societies established libraries for the use of their members: *Kon. Instituut van Ingenieurs, Afd. Indië,* and *Kon. Natuurkundige Vereeniging.* The last institution has a union catalogue for science periodicals.

In this period different "Volksbibliotheken" were founded by private enterprise with staffs who worked mostly *pro deo;* "de Maatschappij tot Nut van het Algemeen," "de Loge" and the Roman Catholic Church were the chief initiators.

*The period 1910-hodie.* — The government took over the organization of the popular libraries, the "Kantoor voor de Volkslectuur" (Balei-Poestaka, Palace of Literature), which provides literature for the Indonesians in their own languages, was founded, and books were placed on deposit in public schools. Since 1916 Dutch public libraries have been established, but they found less interest than the libraries for the Indonesians.

In the 1920's, with the establishment of the Universities, the University libraries were founded. The Law Library has already been mentioned. The Medical College Library has its own building, and in 1939 plans for a new building were ready. Each library has a union card catalogue of the books in its special field available in Java and Sumatra. The College of Medicine is a rapidly growing institution; the number of new students for 1937, ten years after the founding of the college, ranked second in comparison with the four leading medical schools in the mother country.

The "Vereeniging tot Bevordering van het Bibliotheekwezen" was established in 1916, but existed only until 1920. Dr. VAN LUMMEL and Prof. VAN VUUREN founded this association; they did a splendid work, and it is too bad that their task has not been continued by others.

In the journal *Bibliotheekleven* many interesting articles and data on the libraries of the Netherlands Indies may be found. In 1940 Messrs. Kolff of Soerabaja established the *Nieuwsblad voor den Boekhandel in Nederlandsch Oost Indië* (the last number was probably issued in January 1942). The May and June 1941 numbers contain a very extensive account, with tables and statistical data, of the libraries in the Netherlands Indies ("Openbare Leeszalen, Bibliotheken en Volksbibliotheken in Nederl.-Indie"). Some other recent references which may be of interest follow: BERNET KEMPERS, A. J., 1939: De bibliotheek van het K. Bataviaasch Genootschap (Bibliotheekleven 1939, p. 207–210). — BLOYS VAN TRESLONG PRINS, P. C., 1934: Het landsarchief te Batavia (Navorscher 82:259–287; 83:74–96, 97–106). — HASSELT, J. M. VAN, 1939: De boekerij der geneeskundige hoogeschool en andere bibliotheken te Batavia (Bibliotheekleven, p. 105–114). — HASSELT, J. M. VAN, 1938: Het kantoor voor de Volkslectuur (Bibliotheekleven, 1938, p. 122–126). — LUBBERHUIZEN-VAN GELDER, A. M.: Leeszaaltoestanden in Nederlandsch-Indië (Bibliotheekleven 19:113–146). — Neth. East Indies/Departement van Onderwijs en Eeredienst/Kantoor voor de Volkslectuur, 1930: Resultaten (Weltevreden); continued in Departement van Koloniën, Indisch Verslag. — VERHOEVEN, F. R. J., 1940: Geschiedenis van het Indisch archiefwezen van 1816–1854 (Tijdschrift voor Indische Taal-, Land- en Volkenkunde 80, 4).

**Central Depository Library for the Netherlands Indies, 10 Rockefeller Plaza, 14th Floor, New York 20, N.Y.," who will be glad to arrange for the removal of such collections. Especially desired are reports of all kinds dealing with agricultural and industrial enterprises.**

BOARD FOR THE NETHERLANDS INDIES,
SURINAM AND CURAÇAO,
NEW YORK City.

FRANS VERDOORN: **A card index of war-time literature on tropical agriculture of interest to the Netherlands Indies:** — Since the autumn of 1942, on behalf of the Board for the Netherlands Indies, Surinam and Curaçao, I have been going through the principal North American, British, tropical American, and similar and, insofar as possible, certain continental abstracting journals which deal with agriculture, biology and related subjects. Each item, reference, abstract, etc. that referred to tropical and subtropical agriculture (in the widest sense of the word), and could be of some importance, either directly or indirectly, to the Netherlands East Indies I transferred to a card.

I tried not to overload the index. Even so, when I believed it might be of some methodological interest, I have included information about temperate crops and problems.

The following subjects are represented in the index:

| | SECTIONS |
|---|---|
| Introductory | 1–17 |
| Cereals and starch plants | 18–36 |
| Sugar plants | 37–41 |
| Oil plants | 42–54 |
| Coffee — Tobacco | 55–67 |
| Fibre plants | 68–88 |
| Rubber plants | 89–106 |
| Gum and resin yielding plants | 107 |
| Tannin yielding plants | 108 |
| Essential oil plants | 109–114 |
| Spices | 115–122 |
| Medicinal plants | 123–129 |
| Insecticide plants | 130–132 |
| Dye plants | 133 |
| Fruits | 134–148 |
| Potato and vegetables | 149–161 |
| Grassland and forage plants | 162–163 |
| Cover crops and shade trees | 164 |
| Dendrology and forest pathology | 165–170 |
| Ornamental and hedge plants | 171–173 |
| Other economic plants | 174 |
| Weeds and weed problems | 175 |
| Microbiology | 176 |
| Phytopathology and economic entomology | 177–178 |
| Tropical dairying (and books on zoology) | 180 |
| Fisheries | 181 |
| Sericulture | 182 |
| Apiculture | 183 |
| Nutrition | 184 |

The classification used has been based chiefly on the classification scheme of the index of the Colonial Institute of Amsterdam. Every classification, however, is artificial and has its own advantages and disadvantages. A mimeographed booklet reporting in detail the classification scheme followed has been issued on behalf of the collaborators of the Board.

The card index may be consulted in the office of the Board for the Netherlands Indies, Surinam and Curaçao in New York City. As soon as possible, it will be transferred to the Netherlands Indies, and the various sections will be distributed among the principal specialists and technicians in order that they may easily and quickly acquaint themselves with the chief advances of the war years. And it is really amazing how much work in tropical agronomy has been going on all over the world in spite of wartime difficulties!

CHRONICA BOTANICA,
WALTHAM, MASS.

**Recent Bibliographies on the Netherlands East Indies:** — Early in 1945 the Library of Congress published a bibliography of 208 two-column pages on the Netherlands East Indies. Copies of the publication were immediately made available to the allied war agencies, and have been found very useful by many of them.

Despite its size, the bibliography does not attempt to cover all published material in its field. Its emphasis is upon current and relatively recent publications, and an effort has been made to include all important books and periodical articles, available in the U.S.A. and published after 1930 and 1932, respectively. In each instance, a library or libraries in the U.S.A. where the item is located has been indicated.

The *Repertorium op de literatuur betreffende de Nederlandsche Koloniën*, a bibliography of periodical articles from 1866 to 1932, has been discontinued, and the publication now issued by the Library of Congress may be considered a continuation of this work. It is, however, in certain ways more inclusive, as book titles are also — and primarily — listed. Among the wide range of topics covered, the bibliography includes a wealth of anthropological material on the different races of the Netherlands East Indies. The biological sciences, unfortunately, have not always been covered as completely as the humaniora, sociology, etc.

A detailed classification scheme groups the related titles and an analytical table of contents shows on what page a certain class can be found. Class XVII in the text, for example, brings together material on individual islands in the form of multiple cross references to material listed under other classes. The book also contains three indices: one of authors, one of anonymous works, and one of titles for works entered under corporate entries in the text. The latter will be especially helpful to foreign scholars, who are unaccustomed to the American practice of listing official and institutional publications under the name of the issuing organization.

The bibliography was prepared by B. H. WABEKE, E. S. WABEKE, A. SCHELTEMA, M. W. JURRIAANSE, and E. van AALTEN of the Netherlands Studies Unit in the Library of Congress, and was made possible initially by a grant from the Coolidge Foundation. Copies of the work are not distributed by the Library of Congress but are available from the Superintendent of Documents, Washington 25, D.C. at 55 cents per copy.

The following list of some of the principal bibliographies of the past as well as of recent times has been prepared by J. G. VERDOORN, Phil. nat. dra. This list presents only a selection of the principal bibliographies, dealing with the Netherlands Indies. It contains especially volumes of which it was felt that they might be of interest to the readers of "Science and Scientists in the Netherlands Indies." The compiler is under obligation to TH. W. L. SCHELTEMA, Agr. Eng. (Wag.), who kindly sent a number of Library of Congress cards.

Attention should also be drawn to "Basic Bibliographies on India, and Southeast Asia" by ROBERT HEINE-GELDERN and HORACE I. POLE-

MAN, a selected bibliography which will include 1,500 references on Southeast Asia. It will be published late this year by the American Council of Learned Societies, 1219 Sixteenth St., N.W., Washington, D.C.

American Council of Learned Societies/Committee on Far Eastern Studies, 1936–40: **Bulletin of Far Eastern Bibliography,** 5 vols. (Washington, D.C.). — Continued under the title: **Far Eastern Bibliography,** at the ends of the quarterly issues of the *Far Eastern Quarterly*, Vol. 1, 1941– .

BORG, D. and H. BORTON, 1942: **The Far East: a bibliography** (The Booklist 38:289–294).

BROUWER, H. A., 1925: **The Geology of the Netherlands East Indies; lectures delivered as exchange professor at the University of Michigan in 1921-2,** Pp. 160 (New York & London/Univ. of Mich. Studies, Sci. Series, vol. III). — Bibliography, p. 140–146.

COHEN STUART, C. P., 1924: **Bibliografie der Nederlandsch-Indische Theecultuur 1824–1924,** p. 198–241 *in* Gedenkboek der Nederl. Indische Theecultuur 1824–1924; uitgegeven door het Proefstation voor Thee bij gelegenheid van het Theecongres met tentoonstelling (Bandoeng).

CONOVER, HELEN F. (*comp.*), 1942: **The Netherlands East Indies: a selected list of references,** Pp. 46 (Washington, D.C./U.S. Library of Congress, Div. of Bibliography).

DAMMERMAN, K. W., 1929: **The Agricultural Zoology of the Malay Archipelago; the animals injurious and beneficial to agriculture, horticulture and forestry in the Malay Peninsula, the Dutch East Indies and the Philippines,** Pp. 473 (Amsterdam). — Bibliography, p. 401–411.

DE POTTER, A., 1942: **Postwar Reconstruction in the Far East, a selective bibliography,** Pp. 16 (This bibliography was submitted by the American council as a document of the eighth conference of the IPR held in December, 1942) (New York/American Council, Institute of Pacific Relations/ Amer. Council Paper, No. 9).

East Indies Institute of America, New York, 1945: **Selected Bibliographies No. 1. A Selected List of Books and Articles on the Religions of Southeast Asia,** mimeo., Pp. 16.

**Encyclopaedie van Nederlandsch-Indië,** 1917–1938, 2nd ed., 8 vols. ('s Gravenhage).

Geologisch-Mijnbouwkundig Genootschap voor Nederland en Koloniën, 1924– : **Geologisch-Mijnbouwkundige Bibliographie van Nederlandsch-Indië** (Amsterdam).

GONGGRIJP, G. F. E. (*ed.*), 1934: **Geïllustreerde Encyclopaedie van Nederlandsch Indië,** Pp. 1582, ill., maps (Leiden).

GORIS, R., 1939: **Overzicht over de belangrijkste Literatuur betreffende de Cultuur van Bali over het Tijdvak 1920-1935** (Mededeelingen van Kirtya Liefrinck-van der Tuuk, Singaradja, 5:15–43).

's Gravenhage, 1938: **A List of Representative Publications published in the Netherlands mostly of the 20th Century,** Pp. 262 (The Hague/Martinus Nijhoff).

Great Britain India Office, 1909: **Annual Lists and General Index of the Parliamentary Papers relating to the East Indies published during the years 1801 to 1907 inclusive,** Pp. xlvii + 194 (London).

Haarlem/Koloniaal Museum/Bibliotheek, 1908: **Catalogus der Boekverzameling,** new ed., Pp. 208 (Haarlem).

HARTMANN, A. (*comp.*), 1895–1934: **Repertorium op de Literatuur betreffende de Nederlandsche Koloniën, voor zoover zij verspreid is in Tijdschriften en Mengelwerken. I. Oost-Indië, 1866-1893. II. West-Indië, 1840-1893** ('s Gravenhage), etc. — Continuation of "Repertorium op de koloniale literatuur . . . van 1595 tot 1865" by J. C. HOOYKAAS (Amsterdam, 1877–80).

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Bruno Lasker: **Small Industries in Indonesia:** — Throughout history colonial regimes have been noted for the profligacy with which they exploited natural resources. To get at some valuable timber whole forests were destroyed; young soils were depleted with excessive cropping; the health of indigenous populations was sacrificed to the production of export commodities — sometimes in such excess that they rotted on the wharves. Less attention has been paid to another form of waste — the disregard and, often, the unwitting destruction of native skills. Blinded by his preoccupation with the labor requirements of mass production, the colonial employer often deplored the backwardness or "laziness" of the indigenous peasant who could not be persuaded, except under some form of compulsion, to follow the prescribed routine of the plantations and to stick to his monotonous job when he had earned enough to fill his modest wants. Only in recent times, spasmodically here and there, it occurred to some colonials that there might be a potential resource in some of those skills that had been preserved in the native section of the colonial economy — a resource overlooked by previous generations.

In the Netherlands Indies, in advance of other colonial regimes in many respects, the native handicrafts were protected even in the nineteenth century. There were three reasons for this: the people were too poor to substitute imported manufactures for the simple clothing and articles of use to which they were accustomed; it was desired to interfere as little as possible with their established way of life; and some products of their crafts had an artistic quality that made them desirable objects of trade. The last-named reason was, of course, the least important. Indeed, it only came into play when the more highly developed crafts had already almost died out as the taste of native patrons changed from batik to French brocades and from wood carvings to shining brass.

It is to the credit of the Netherlands Indies Government that it was one of the first to recognize the relation between political, economic, and cultural objectives. Support — and in some instances restoration — of traditional crafts was as much a means of maintaining a stable social order as was the re-inforcement of customary law and the protection of the Indonesian peoples' right to their land.

Since the eighteen-nineties, the program became more positive. The native side of the economy was not only to be preserved, it was to be built up. When millions of Indonesians had become dependent on world prices for their primary export commodities, the economic self-sufficiency of the rest of the population could not be allowed to remain equally precarious; on the contrary, it had to become elastic enough to offer a reliable alternative in years of low prices. It is true, when the world economic depression broke over the Indies in the early 'thirties of this century, all the precautions taken proved insufficient; but at least there had been preparation for just such a catastrophe, and on its basis other measures could be improvised. Already great technical improvements had taken place both in agriculture and in

the crafts. Whole communities were able to return from a money economy to one of barter without too dangerous a fall of their plane of living.

Some of the crafts, indeed, had become transformed into incipient industries. Geographical specialization and commercial organization had widened their markets; many of them were mechanized, and some were run by native owners versed in modern methods of management. Secondary industries had begun to play a role in the exports of the Indies. In the first stage, raw materials of little value — rattan, various straws and fibers, bamboo, dyes, soft woods — had become marketable when clever fingers had converted them into textile fabrics, hats, mats, batik, articles of furniture and ornament. In the second stage, unemployment and underemployment compelled a rationalization of production. Qualities had to be raised and standardized, costs of transportation and marketing had to be cut. Industrialization was in full swing.

It may seem paradoxical that just at a time when the native crafts were threatened with extinction by the impact of cheap, imported manufactures, they should have experienced a resurrection. But the explanation does not lie in some chance coincidence. The methods used were wholly in consonance with the principal economic policies of the Government. Like all colonial governments that of the Indies had historically been opposed to the development of industries that might compete with those in the home country. But times had changed. Only a deliberate development of all the dependency's resources could save its contribution to the motherland and advance its own prosperity.

Mr. SITSEN, whose account of the new industrial policy for the Indies and its working out is the occasion for this paper * took a leading part in its formation. When, many years ago, he became Director of the Industrial Division in the Department of Economic Affairs, he found an industrialization program under way, but it is he who is reputed to have solved some of its most vexing technical and financial problems. It required an unusual concern for the welfare of the Indonesian people and unusual vision to recognize in the manufacture of consumer goods the key to the economic salvation of the dependency in a time of stress; for, that salvation had to be accomplished while the danger of aggression from Japan became more threatening and while the mother country had to rely more than ever on the economic support of its dependencies.

In stressing the significance of one element in the industrial program, the development of crafts into power-using mechanical industries, it is not intended to detract from the importance of other elements in the program. Above all, it is the merit of the Netherlands Indies scheme that it does not set off industry against agriculture but sees in the intensification of both a single comprehensive method of raising the standard of living and the value of the dependency's exports. They were conceived as complementary, and care is taken not to achieve success in one at the expense of the other. Similarly, holding on to a policy primarily motivated by considerations of welfare — which includes the need for larger revenues to support the growing complexity of the apparatus of government — the Government avoided the concflit between the requirements of large and small, heavy and light industries.

Only by keeping in balance the stimulated growth of every form of production with a legitimate social purpose could the remarkable results be achieved which Mr. SITSEN has displayed. An illuminating estimate of the shift from primary to secondary production in terms of employment and income shows that at some time between 1935 and 1939 the Indies reached that balance between the two which the United States had achieved around 1870. In not much more than a decade or two, the dependency, though still predominantly agricultural, had come to rely on industry for a large part of its income. The social by-products are equally important. When the Japanese invaded the Indies, they found not only practically all the manual workers in industry to be indigenous, but natives held three out of every four overseer positions and about one of every four managing positions. The progress from old-fashioned colonial plantation and mine regime toward industrial democracy was definitely under way.

What made possible the rapid growth of secondary production in the Indies was not an unusual wealth of industrial raw materials but an unusual thoroughness in the application of scientific knowledge. Few countries in a similar phase of their economic development have to show anything like the series of painstaking surveys by means of which Mr. SITSEN's department sought to guide its policies. The chemical and the social laboratory alike contributed to a remarkable sureness of advance. The management of shops and factories, methods of employment and sale, the functional relations between mechanized and non-mechanized industries, and not least the training of workers for modern forms of production presented a multitude of problems, not all of which were fully overcome, but all of which were studied. In one year, 1940, five hundred new factories were registered, with 23,000 workers. The shortage of skilled and semi-skilled workers had become acute.

In this period of transition, working conditions are very uneven. Some power-using factories compare favorably in this respect with those in similar industries in the West, others are little more than enlarged sweatshops and recruit their workers, as best they can, among an ignorant peasantry as yet hardly able to appraise the value of its labor in money terms. Primitive labor conditions, of course, perpetuate primitive attitudes toward employment, so that in some sectors of Javanese industry the rate of worker absenteeism alone would make an efficient production schedule impossible. However, the educative influence of industrial employment and of the mobility to which it has given rise has become a factor of first importance in the economic prospects of the Indies. Large numbers of men and women, as yet little emancipated from the simple beliefs and usages of the Indonesian village, take part in modern processes which make them more alert to the actual changes in their conditions and prospects. The need for scheduled and concerted action, the relation of reward to concrete and measurable contributions of service — all sorts of new experiences bring awareness of realities which were not so much absent from the traditional way of life as they were unrecognized. People learn, not to adapt themselves to a differ-

* PIETER H. W. SITSEN, *Industrial Development of the Netherlands Indies*, Bulletin No. 2 of the Netherlands and Netherland Indies Council of the Institute of Pacific Relations, New York ,1944, 65 pp., paper, $0.50.

ent kind of world, but to understand their own and make the most of it.

As long as the Indies are economically dependent on world markets, the people will be basically insecure. But the present transitory stage, unsatisfactory though it is in so many respects, offers that very flexibility which is the people's only safeguard. Since large numbers can transfer their working power back and forth between food production and the production of industrial raw materials, between agriculture and simple secondary industries, they are at least somewhat safe from danger of starvation. Eventually, of course, the sweatshop and the somewhat primitive industrial plant, too small to be efficiently run, must go. The Indies, and especially Java, need that degree of intensification of production which precludes the maintenance of too large a "traditional" sector in the country's economy — and this quite independently of the size of agricultural holdings or the industries yet to be introduced.

Mr. SITSEN, who guided the process of industrialization through its first stage was not given to much generalization and would, perhaps, not have agreed with everything here said. But it is possible to distil from his discussion the following major requirements for the future economic welfare of the Indonesian people. First, a rising purchasing power of the great farming population, still two-thirds of the people, is the prerequisite for a more rapid industrial growth. Second, Indonesian industry can no longer afford to produce consumer goods only for local markets but must endeavor to find also some foreign outlets, especially in the industrially less advanced neighboring lands of the Asiatic continent. Third, industrial production must as far as possible derive from the processing of local raw materials and be non-competitive with the complicated manufactures of older-established industrial countries. Fourth, the larger national income derived from higher forms of production must be distributed in such a way as to spread higher purchasing power among all classes contributing to that production. Fifth, native enterprise gradually advancing from one stage of proficiency to another is preferable to the introduction of full-fledged modern industries under foreign control.

AMERICAN COUNCIL,
INSTITUTE OF PACIFIC RELATIONS,
NEW YORK CITY.

ADRIAAN VAN DER VEEN: **In Memoriam P. H. Sitsen:** — When PIETER HENDRIK SITSEN died after a brief illness in Sydney, Australia, last January 21, 1945, most of the Netherlands Indies was still occupied by the Japanese. Consequently the word of his passing could only spread to the relatively few Hollanders outside of the then occupied territories in Europe and in the Pacific. We may expect that when peace has returned to the whole of the Netherlands Kingdom and when the balance has been made up for all of these eventful war years, additional respect will be paid by a whole nation to the memory of this great Hollander. SITSEN will deserve this because he was one of the few men whose fervent idealism is expressed in deeds, in hard, never ending work. He was the perfect combination of the idealistic and practical man, one of those outstanding Hollanders responsible for the good reputation of Dutch administration in the Netherlands Indies.

SITSEN was born on January 11, 1884 in Bergen op Zoom in the province of Brabant. He studied at the Cadet Academy in Alkmaar for two years, and thereafter at the Military Academy in Breda for three years where he became a lieutenant in the engineering corps. As he intended to make his career in the Indies he specialized in railroad construction. Subsequently he was sent in 1906 to Northern Sumatra where he helped build the strategic Atjeh railway. Then SITSEN was entrusted with the construction of roads and bridges. He planned the highways that later opened up the huge, fertile island of Sumatra.

In 1909 SITSEN was sent to Java, where he helped organize the Netherlands Indies Army, which up to that time had consisted mainly of small units. In 1912 he resigned from military service and became Director of Municipal Works in Batavia. Sometime thereafter he became Director of Regional Works in Mid-Java. Feeling, however, that he needed greater freedom to build, he left Government Service and established his own construction bureau. For the following twenty years he played a great part in the construction and modernization of the Netherlands Indies cities, bridges, railways, water-works, factories and irrigation projects, as is pointed out in an excellent article about SITSEN by the well-known Dutch-American writer ALBERT BALINK in the *Knickerbocker Weekly*, which is the source of most of the following information.

SITSEN had in the meantime become a fervent advocate of native progress, and in 1919 was one of the organizers of the first Javanese culture congress from which was born the Java Institute for the furtherance of knowledge about the native world. One of the Java Institute's most highly priced achievements was the native museum in Djocja, of which SITSEN was one of the founders.

SITSEN has always been one of the most active figures in the ethically inclined group of progressives who created a definitely new trend in relations between brown and white. The movement centered around the Java Institute and the monthly magazine "Djawa." This new spirit, of which SITSEN was one of the foremost representatives, did much toward erasing the old ethnical and social barriers which had kept European and Indonesian from fraternizing. It is not surprising that many of SITSEN's intimate friends were Indonesians.

Astounding progress was made in the Netherlands Indies during the last decade. The position of the native population improved immeasurably. One of the results of this progress was a growing demand for industrial articles. Consequently the industrialization of the Indies was greatly promoted, and SITSEN was again one of the champions of this new development. He encouraged native industry and labor by building up the pride of the natives in their handiwork. He founded several craftsmen's guilds. He insisted on the use of more imagination in technical instruction in the schools. His efforts did not remain unobserved by the government: in 1934 he was given the post of head of industry of the Department of Economic Affairs. SITSEN now devoted his energy toward making the Netherlands Indies self-sustaining. He championed establishment of textile industries in Java and he recognized the need of a native shoe industry. At first it was difficult to overcome opposition from Netherlands industry, but it was finally acknowledged that industrialization of the Indies would in the long run be beneficial for the homeland as

well, because only if the standard of living of the native population rose, would they be able to buy more imported articles. The success of SITSEN's work can best be judged by the fact that in 1940 the income of natives from new industries alone amounted to 450 million guilders per year. SITSEN has given a detailed description of his labors in a booklet "Industrial Development of the Netherlands Indies," which was published by the Netherlands and Netherlands Indies Council of the Institute of Pacific Relations.

SITSEN was one of the few leading men who were instructed by the Netherlands Indies Governor-General to evacuate the Indies shortly before the Japanese occupation. They were to leave their families behind and devote themselves to the work of the reconstruction of the country. It is no exaggeration to say that SITSEN in following the Governor-General's instructions literally worked himself to death. Fortunately before he passed away he had completed the crowning task of his life: the creation of a blueprint for relief and rehabilitation of the Netherlands Indies. This Master Plan is the basis for the vast relief and rehabilitation machinery, ready to function as soon as Indonesia, for which country SITSEN lived and died, is completely liberated. His name will live on in the hearts of Netherlanders and Indonesians alike.

BOARD FOR THE NETHERLANDS INDIES,
SURINAM AND CURAÇAO,
NEW YORK CITY.

ADRIAAN VAN DER VEEN: **In Memoriam G. H. C. Hart:** — When GEORGE HENRY CHARLES HART died in London on September 3, 1943, at the age of fifty, he had finished a versatile and in every respect a successful career.

He was born August 9, 1893. After the completion of his law studies at the Municipal University of Amsterdam in 1920, he became connected with the Secretariat of the Association of Employers of the Java Sugar Industry at Surabaya. In 1932 he was made chairman of the Association of Entrepreneurs, an organisation comprised of the large industries in the Netherlands East Indies. That same year he occupied a seat, obtained by appointment, in the People's Council. Two years thereafter, in 1934, the government invited him to become director of the Department of Economic Affairs at Batavia. A severe illness obliged him to resign this office after three years and to leave the East Indies in August 1937. He became chief of the Eighth (Economic) Division of the Ministry of Overseas Territories at The Hague. After the invasion of the Netherlands Dr. HART continued his work in London, first in his former capacity and later as Secretary-General. When a Netherlands Economic and Financial Mission was established in the United States, Dr. HART in July 1942 went to America, where, as chairman of the Commission, to the very last he pioneered for the benefit of the Netherlands East Indies. In London, where he had gone for conferences in July 1943, he was prostrated in the middle of August on the sickbed from which he was never to rise.

By restricting oneself to an enumeration of bare achievements in delineating a person like Dr. HART, one runs the risk of failing to do him justice. He was so much more than facts alone can reveal. Few persons understood this better than the Minister of Overseas Territories, Dr. H. J. VAN MOOK, who in an excellent obituary in *Vrij Nederland* of September 11, 1943, regretted particularly that Dr. HART's friends and co-workers would henceforth have to do without the great and stimulating influence of his vivacious mind and of his sensitive, helpful temperament.

Minister VAN MOOK also referred to one of Dr. HART's characteristics which would remain undisclosed in a recital of achievements alone. He directed attention to the sometimes disconcerting multiplicity of interests which Dr. HART possessed. In many instances such versatility leads to superficiality and lack of concentration. In the case of Dr. HART, however, this did not detract from his great energy and perseverance. In spite of the vivaciousness of his personality, Dr. HART always kept the main lines in sight; he always aimed right at his goal.

Probably just this combination of a versatile interest, which prevented him from running aground in too narrow a routine, and a high degree of concentration on the task to be performed enabled Dr. HART, in the most difficult time which the Netherlands East Indies passed through during the world crisis and war years, to accomplish great and important work for this portion of the Realm. As chairman of the Association of Entrepreneurs, he had an important part in the preparation of international production regulations, in which domain he developed himself into one of the leading experts in the world. As East Indies member of the Netherlands delegation for the first Japanese negotiations at Batavia in 1934, he began to show his competence in the international sphere. But his special accomplishments were fully displayed only in 1934 in his capacity as director of Economic Affairs at Batavia. Dr. VAN MOOK, who collaborated closely with Dr. HART at that time, points out, in the article previously cited, that in the difficult year 1934 no one was better suited for the post of director of the Department of Economic Affairs than Dr. HART. "Into the increasing activity of the government in the field of economics and industrial life," said the Minister, "someone who had that part of society at his finger's ends and who enjoyed the confidence which could bridge many a difficulty in the first years of this new alliance was needed. His knowledge of human nature gave him the opportunity to elevate the Department of Economic Affairs to great efficiency and adroitness by the choice of new co-workers; his tactical gifts made him a master in the negotiations with many opposing forces, within the country and without."

Although later in the Netherlands Dr. HART, as chief of the Economic Division, often spoke sadly about the East Indies, where more than elsewhere creative work was possible, it was precisely in his new capacity, according to Minister VAN MOOK, that he developed in the long run perhaps his greatest ability. "In London, in Paris, and elsewhere he was, at international gatherings, the unwearied representative of the interests of the East Indies; in the Netherlands, the unwearied intermediary between the restive domain overseas and the thoughtful mother country."

This insatiable zeal for work assumed a tragic character after the overwhelming of the Netherlands and the fall of the East Indies. He was incited to an activity which could never be great enough for his temperament. He was always conscious of the fact that, whatever he might accomplish, he could never acquit himself entirely of the gigantic task which rested upon his shoulders; and that consciousness impelled him, not-

withstanding his weakening physique, to still greater activity. It is a miracle that Dr. HART, during the year that he spent in the United States, in spite of the anxieties about his family and relatives in the Netherlands and the sorrow about his compatriots oppressed by the Nazis, always cheerfully continued to direct his group of co-workers. He remained to the end the same friendly, kind-hearted man he had always been.

It is equally typical of Dr. HART that he consistently did his work, no matter how much it piled up, with his accustomed care. In his letters, his lectures, and his more ambitious writings, such as the booklet *Towards Economic Democracy* (which he was able — no one knows how — to write in the evening hours), he always remained the meticulous, perhaps even somewhat mannered, stylist. No matter how aroused he might feel, no matter how conscious he always was of the pressure of work, he took pains to see that his prose retained the logical flow of thought of the jurist, the somewhat cumbersome, yet great clarity of the trained first-class public servant.

*Towards Economic Democracy* is a work that is highly characteristic of Dr. HART. The book is undoubtedly not the expression of a scientific man who speaks plain language, regardless of the consequences. After having followed the line of thought, one can reach no other conclusion than that this booklet was written by an adroit diplomat who had the gift of disguising himself temporarily, if need be, as an able author. It is then easier to understand that Dr. HART, in the writing of this work, as well as in his action at international conventions or meetings of whatever kind, had only a single aim in view, namely, to advance the arguments which at the suitable moment would make the most favorable impression, and by which his country could best be served. Of this difficult art of maneuvering, of shifting one's position, whereby it is at one time desirable to adhere to one's point at any price, while at another time it is better to accept a compromise, Dr. HART was a master.

In the history of civil administration in the Netherlands Dr. HART earned his place as a competent, devoted public servant, in the best sense of the word. However much he sympathized with his family in the Netherlands, his country occupied an ever-increasing place in his mental and emotional life. His death during the decisive war years was, therefore, profoundly mourned. It is, however, the greatest tribute which can be paid to the memory of Dr. HART that, although he was an irreplaceable official, he was missed primarily as a man, good through and through, who in the course of his lifetime brought an untold amount of benefit to others. For that reason his death was for a great many people a personal loss; for that reason the remembrance of him will remain alive.

BOARD FOR THE NETHERLANDS INDIES,
SURINAM AND CURAÇAO,
NEW YORK CITY.

S. VAN VALKENBURG: **The Topographical Service of the Netherlands East Indies:** — The Topographical Service of the Netherlands East Indies can look back on a long period of valuable work. As a branch of the Army and working originally under the Engineering division, it became a separate unit in 1874 (although remaining under the General Staff), while in 1907 it obtained virtual independence as the ninth division of the War Department.

The task of mapping all the islands under the control of the Netherlands was a tremendous one, especially since the size of the service was limited as a result of financial restrictions. Taking that into consideration, the results are excellent. At present the remapping of Java on a scale of 25,000 (the published maps are on a scale of 1:50,000) has been completed, replacing the old maps on a scale of 20,000, 40,000 and 80,000. Of the Outer Provinces almost one-half are now finished in detailed maps (scale 1:50,000 and 1:100,000), while temporary sheets are available for some of the other sections. The mapping of Sumatra is almost entirely completed, also Bali, Southeast Borneo, Southwest and Central Celebes, Timor and Soemba. These maps not only present the terrain features, such as topography and rivers, but also indicate the type of crops raised and the character of the vegetation. The mapping of New Guinea by aerial photography was all planned when the war interrupted the work. While the original motive for mapping was a military one, its present function has become one of general service. Careful maps in many instances further the economic development of retarded areas. The tax system of native property (so-called land rent) has its foundation on detailed mapping of properties. To give one recent example, in the last years preceding the Japanese invasion, mapping was underway of all the native rubber gardens on a scale of 1:5,000 in order to have accurate knowledge of their extent in relation to the rubber restriction.

At the headquarters of the Topographical Service at Batavia, the detailed sheets were used for large scale maps which could be of service to the general public. Road maps for the automobile clubs, tourist maps, and school maps were all derived from the original sheets. While the organization remained of a military nature, with a colonel as chief, civil experts were called in to help. The triangulation was chiefly in the hands of engineers; a geographer helped in the compilation of general maps and also assisted in the training of young cartographers. Many publications of scientific and general interest showed that the members of the staff were not only interested in mapping but also saw the relation between maps and economic and human interests. A great deal of the actual work was done by specially trained native surveyors who proved to have great skill in that field. Special mention should be made of the Reproduction Section where native draftsmen made some of the finest maps published. The sheets of the 1:1 million world program (involving all nations of the world) show the high quality of the work done.

It would take too much space to mention the names of all the men who helped to give the Topographical Service its international reputation. Among the older directors W. J. HAVENGA, H. HELB, H. D. H. BOSBOOM and J. J. K. ENTHOVEN were perhaps the outstanding figures. More recent directors were A. VAN LITH, L. F. VAN GENT, H. J. K. SCHUITENVOERDER, J. W. E. DE RUITER and V. DERSJANT. Among the chiefs of the Triangulation Brigade the names of Prof. Dr. J. J. A. MULLER and Prof. Ing. J. H. G. SCHEPERS deserve special mention while under the direction of J. W. TEILERS the Reproduction Section reached a high level of quality. However, it would not be fair to the many others not to state that the results obtained were due to a strong "esprit de corps" between all, from the native topographer upwards to the commanding officer.

In this war and in planning the reconquest of

the Archipelago, the thousands of detailed sheets — now printed in the United States — have been of immense value. No one appreciates the existence of good maps more than the military leader who has to plan an invasion or direct an air raid. The work of the Topographical Service, often done under the most difficult conditions of terrain and climate, deserves the highest praise. It is a job well done.

School of Geography,
Clark University,
Worcester, Mass.

E. Adamson Hoebel: **The Contribution of Professor Raymond Kennedy to Indonesian Ethnology:** — Among American ethnologists, Raymond Kennedy stands without peer in his knowledge of Indonesia. American anthropologists, who have done actual field work in the East Indies (excluding the Philippines), can be counted on the fingers of one hand. Mead, Loeb, Provinse, DuBois come to mind. But each of them has worked in limited areas on limited problems. It was Professor Kennedy's good fortune that his pre-academic career in business took him to the Indies for a long stay early in life. It is the good fortune of social science that he was naturally endowed with the intellectual curiosity and aptitude to become keenly aware of the significance of the varied peoples and customs with which he came in contact. To the foundation of his own first-hand experience in the Indies, he has added a detailed knowledge of much of the Dutch literature in which most of the ethnological data concerning the area are locked — so far as most English-speaking Americans are concerned.

A review of Kennedy's writings, such as have been published to date, would hardly do justice to the contribution which he is making to the science of Indonesian ethnology. He has preferred to concentrate on one comprehensive ethnography of the entire region, rather than to produce a series of monographs or shorter papers. In fact, he has so far put only one original, limited factual study into print. This was his very first publication — a description of bark-cloth manufacture in Indonesia — a comparative analysis of technology and linguistics of bark-cloth complexes of Indonesia and Polynesia. He convincingly demonstrates detailed similarities, which prove the two complexes to be nearly identical. But this is as far as he goes, except to suggest other similarities may be found which "will result in the establishment of far-reaching correspondences and relationships between the two areas . . . lending objective scientific substantiation to hypotheses of connection and migration which up until now have never been properly corroborated by comparative factual data." [1]

At the outset, Kennedy revealed a healthy aversion to any tendency to hypothecate without facts.

This scientific quality of his mind comes out most strongly in two critical communications to the American Anthropologist written in 1936 and 1939.[2] Each is a vigorous protest against recent works by fellow Indonesianists. One he criticizes for faulty and careless method, sampling chapter and verse to substantiate his dissatisfaction. The other he praises for the high quality of its descriptive ethnology, but devastatingly criticizes for its *a priori* interpretative hypotheses into which the author strains to place his data. Throughout both these communications Kennedy reveals three valuable qualities; (*1*) detailed knowledge of the facts about Indonesian native life, (*2*) craftsman-like standards of accuracy, organization and scholarship, (*3*) critical caution towards generalized schemes of interpretation and interpolation of social and historical data. Thus, in a negative way, Kennedy has revealed what we may expect of him when he makes his real positive contribution.

It is necessary to speak of Kennedy's real contribution as something forthcoming rather than in-being. He has a four-volume ethnology of Indonesia in process of creation. Truly, Professor Kennedy is putting all his eggs in one basket. A number of years of painstaking effort had brought the author close to the threshold of completion of his project when the war intervened with its claims for the use of his expert knowledge in the services of the government. As planned, the first volume will cover Sumatra, the second, Borneo and Celebes, the third, Java and Bali, while the fourth will be devoted to the Lesser Sundas (Bali excepted) and the Moluccas. The people of each island are to be described as they are found today. Then the study will move back in history to show how various social influences have worked to bring them to their present state. Professor Kennedy is not anti-historical in the least. How could a student of Indonesia ever be? He is merely anti-historical-phantasia. Finally, the forces and trends affecting the immediate futures of the various peoples will be subjected to an attempted analysis.

This is a vast and ambitious undertaking. For the first time, when it is completed, we shall have a systematic ethnology and social history of all the East Indies available in English — or any language, for that matter. It bids well to be an epochal accomplishment.

At the time of this writing Professor Kennedy has just sent a valuable and useful undertaking to the press. By the time this book has appeared, his Bibliography of Indonesia should also be available.[3] It is a complete [4] listing of titles on the peoples and cultures of the Indies, classified by islands and tribes. It has the interesting feature of listing Dutch references separately from those appearing in English, French, German, or other languages, in order to facilitate its use by non-readers of Dutch.

In another vein, Professor Kennedy has published a number of brief, comprehensive summaries of Indonesian culture for popular and semi-professional orientation. They are clear, concise statements and generally well-written. Several appeared as chapters in various symposia, one as a war handbook of the Smithsonian Institute, and one as a successful popular, trade book.

In the crisis of the hour, Professor Kennedy has expressed his views on Dutch colonial policy

[1] R. Kennedy, "Bark-Cloth in Indonesia," Journal of the Polynesian Society, No. 172, December 1934, Page 243.

[2] R. Kennedy, "A Survey of Sumatra," American Anthropologist, N. S. 38, 1936, Pages 146–148.
R. Kennedy, "The 'Kulturkreislehre' Moves Into Indonesia," American Anthropologist, N. S. 41, Pages 163–169.

[3] The bibliography will be published in the Yale Anthropological Studies, Yale University Press, New Haven, Conn.

[4] Kennedy feels that it includes at least 95 per cent of all the works which have ever been published on the peoples and cultures of the islands.

from the lecture platform or the speaker's dinner table on a number of occasions. Two of these addresses have been preserved as papers in the proceedings of learned societies.[5] While appreciative of the solicitude of the Dutch for native culture, and frankly in admiration of the anthropological training given the Netherlands civil servants in preparation for administrative posts in the Indies, Professor KENNEDY raises doubts as to the appropriateness of the Netherlands' method for the Indonesian peoples, who have a future to meet in the modern world. The failure of the Dutch to provide higher education in science and politics for the Indonesians is the object of his sharpest attacks. The educational system of the Indies comes in for reiterated unfavorable comparison with what the Americans have accomplished in the Philippines. The problem of "education for what?" is always moot. But so far as the Indies are concerned, Professor KENNEDY expresses little doubt. Nor is his critical attitude of the Dutch policy on education merely nationalistic. He turns the tables on the United States when it is a matter of preserving the landed heritage of Indonesians and Indians.

It is too early to know whether Professor KENNEDY's views will have any direct influence on future colonial policy, but his views are given forthright expression by voice and pen.[6]

DEPT. OF SOCIOLOGY AND ANTHROPOLOGY,
NEW YORK UNIVERSITY.

L. LEK: **The Snellius Expedition***: — The Society for Scientific Research in the Netherlands Colonies and the Royal Netherlands Geographical Society together took in 1925 the initiative for organizing an oceanographic expedition to the waters of the Netherlands Indies Archipelago. While in the Siboga-expedition of 1900, biology stood in the foreground, physical oceanography came only in the second place and geology was not included in the programme at all, in the Snellius expedition the parts were reversed and, moreover, a prominent place was given to geology. Thus the one expedition formed a complement to the other and the combined results were enriched by the gravitation researches of Prof. Dr. F. A. VENING MEINESZ on Netherlands submarines in the seas surrounding the Archipelago.

The expedition ship, H. M. "Willebrord Snellius," was under command of Lt. F. PINKE. The leader of the expedition was Mr. P. M. VAN RIEL, Chief of the oceanographic and maritime-meteorological section of the Royal Netherlands Meteorological Service. The members of the scientific staff of the expedition were: Prof. Dr. H. BOSCHMA, biologist, Dr. PH. H. KUENEN, geologist, Dr. A. B. BOELMAN, chemist, Dr. H. C. HAMAKER, physicist, and Mrs. M. M. H. VAN RIEL-VERLOOP, assistant for chemical determinations.

The sea area investigated is limited by parallels Lat. 10° N. and Lat. 12° S. and by the meridians Long. 112° and 135° East and covers about three million square kilometres.

During the period between July 27, 1929 and November 15, 1930, a distance of almost 34.000 sea miles was covered. Over this area the marine personnel carried out more than 32000 depth determinations. During the cruise the salinity and temperature of about 2000 water samples from the surface were determined; the temperature was, moreover, continuously registered independently by a resistance thermometer fixed outside the hull of the ship. While stationary, observations were made at 373 stations. Of these, 353 were ordinary stations, eight were anchor stations, at 11 stations only a bottom sample was obtained and at one station only biological observations were carried out. The temperature was measured at fully 7300 points between the surface and the bottom; simultaneously about the same number of water samples were raised from the niveaus and examined on board. This research included 7100 salinity and almost 5300 oxygen determinations. The salinity was obtained from at least two chlorine titrations, the oxygen determinations were carried out in duplicate. The further chemical determinations consisted of over 700 alcalinity, about 5700 hydrogen-ion-concentration, 200 phosphate and 6 $H_2S$ determinations.

At 8 places the ship was anchored at a maximum depth of somewhat less than 5000 meters to carry out current determinations at various depths and to collect data concerning the variations in the properties of the sea water at different niveaus.

At almost every station plankton was obtained from the surface, while at the stations and also several times under steam organisms were caught from the deeper layers with the vertical net or townet. A few dredgings were made. On the

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[5] R. KENNEDY, "Acculturation and Administration in Indonesia," American Anthropologist, N. S. 45, 1943, Pages 185–190.

"Applied Anthropology in the Dutch East Indies," Transactions of the New York Academy of Sciences, Series II, Volume 6, 1944, Pages 157–166.

[6] He has contributed a chapter entitled, "The Colonial Crisis and the Future" to the volume, *The Science of Man and the World Crisis* (*ed.* RALPH LINTON), which has just been published (December, 1944).

* The following reports of some recent expeditions and explorations in the Netherlands Indies may be of interest to the readers of "Science and Scientists in the Netherlands Indies": —

ARCHBOLD, R., 1941: **Unknown New Guinea; American scientists discover a valley of 60,000 people never before seen by white men** (National Geogr. Magazine 79:315–338).

ARCHBOLD, R., A. L. RAND and L. J. BRASS, 1942: **Results of the Archbold Expeditions, no. 41: summary of the 1938-1939 New Guinea expeditions** (Bull. Amer. Museum of Natural History 79:197–288).

BIJLMER, H. J. T., 1938: **De Mimika-Expeditie 1935-1936 naar Centraal Nieuw-Guinea** (Tijdschr. K. Nederl. Aardrijksk. Genootschap 55 (2s):240–259).

BRASS, L. J., 1941: **1938–39 Expedition to the Snow Mountains, Netherlands New Guinea** (Journal Arnold Arboretum 22:271–295).

BROUWER, DOEKE, 1939: **Kort Verslag van het Medisch en Anthropologisch Werk in het Merengebied** (Tijdschr. K. Nederl. Aardrijksk. Genootschap 56 (2s):785–792).

BROUWER, H. A., 1940: **Geological Expedition of the University of Amsterdam to the Lesser Sunda Islands in the Southeastern Part of the Netherlands East Indies 1937,** 2 vols. (Amsterdam).

COLIJN, A. H., 1937: **Naar de Eeuwige Sneeuw van Tropisch-Nederland. De bestijging van den hoogsten top van het Carstenszgebergte** (Tijdschr. K. Nederl. Aardrijksk. Genootschap [illegible]).

**Expeditie naar de Goenoeng Loeser in Atjeh** (Indische Gids 59:561–562, 1937).

HELDRING, E., 1939: **De Expeditie van 1939 van het K. Nederlandsch Aardrijkskundig Genootschap naar het Nassaugebergte op Nederlandsch Nieuw-Guinea** (Tijdschr. K. Nederl. Aardrijksk. Genootschap 56 (2s):305–320).

KLEIN, W. C., 1938: **De Militaire Exploratie van Nieuw Guinea tijdens de Regeering van Koningin Wilhelmina** (Indische Gids 60:933–941).

KLEIN, W. C. 1938: **Resultaten der Amerikaansch-Nederlandsche Archbold-Expeditie; Nederland dient er op voort te bouwen** (Koloniaal Tijdschrift, Sept. 1938:669–675).

LEROUX, C. C. F. M., 1939: **De Expeditie van het K. Nederlandsch Aardrijkskundig Genootschap naar het Wisselmerengebied en het Nassaugebergte op Nederlandsch Nieuw-Guinea in 1939** (Tijdschr. K. Nederl. Aardrijksk. Genootschap 56:661–679, 765–762).

coral reefs corals and other biological material were collected, from shallow water and from the sea shore.

While stationary 349 wire soundings yielded about 300 bottom samples. The maximum length of the bottom samples amounted to 206 cm; the greatest depth from which deep sea ooze was raised was 10.000 meters. The geological investigation was not confined to the configuration and properties of the sea bottom, but included coral reefs and little-known islands. The ordinary observations for the meteorological log taken by the naval officers were supplemented by observations concerning rainfall, humidity and the sun's radiation.

The results of the expedition were published in "The Snellius-Expedition" (Leiden: E. J. Brill). Of this the following parts have been published: Vol. I, Chapter I: P. M. van Riel, Programme of research and preparations (1937). — Vol. I, Chapter II: F. Pinke, The expeditionary ship and the Naval Personnel's share (1938). — Vol. I, Chapter II: Appendix, J. P. H. Perks, Voyage. The deep sea Anchorage Equipment (1938). — Vol. I, Chapter III: P. M. van Riel, The voyage in the Netherlands East Indies (1938). — Vol. I, Chapter IV: H. Boschma and Ph. H. Kuenen, Voyage. Investigations on shore. — Vol. II, Part 2, Chapter I: F. Pinke, Oceanographic Results. Depth determinations (1935). — Vol. II, Part 2, Chapter II: P. M. van Riel, Oceanographic Results. The bottom configuration in relation to the flow of the bottom water. — Vol. II, Part 3: L. Lek, Die Ergebnisse der Strom- und Serienmessungen auf den Ankerstationen (1938). — Vol. III: S. W. Visser, Meteorological Observations (1936). — Vol. V, Part I: Ph. H. Kuenen, Geological interpretation of the bathymetrical results (1935). — Vol. V, Part II: Ph. H. Kuenen, Geology of coral reefs (1933). — Vol. VI: H. Boschma, Biological data (1936).

La Jolla, Calif.

B. Landheer: **Education in the Netherlands Indies, A Symposium:** — The Netherlands University League gave, once more, evidence of its great interest in the acute problems of our time by devoting its 6th Annual Meeting to the reconstruction of post-war education. The meeting which was held in the pleasant surroundings of the Princeton Inn, Princeton, N.J., on January 28th and 29th, 1944, was attended by many members of the League and distinguished guests from Princeton University and the Institute for Advanced Study.

The subject was timely because education in all its aspects will be one of the main problems and responsibilities of the immediate post-war period. The present world conflagration is more than a battle between armed forces, it is a conflict between civilization and barbarism, between well established spiritual values and the craze of racial superiority. In order to vindicate their claims to an undisputed monopoly of world-domination in all cultural fields, the Nazis wilfully attempted to pervert the moral, spiritual and scientific bases of life in the conquered regions. Their chief aim was to break the real strength of the occupied nations before their liberation would have become a fact. They especially concentrated on the general nazification of the various educational systems. It is almost a truism that an uneducated people cannot be a free people. Before the invasion, education in Holland was the immediate expression of the democratic character of Netherlands life. It is therefore by no means surprising that it became a first object of Nazi destruction.

In the Netherlands Indies popular education used to be one of the chief concerns of the Government. A well balanced system ranging from elementary to higher education had been developed to provide for the various needs of all Indonesian and Dutch groups. An important principle was the use of native languages as medium of instruction. As a result illiteracy was declining rapidly. In following this trend, the government had taken great pains to bring modern improvements to the Indonesian educational system without destroying the possibilities for further development of the age-old indigenous civilization. On the contrary, the Japanese, at present, are endangering this civilization by consistently nipponizing all schools, with a view to bring Indonesian life under the domination of Japanese "Co-prosperity" imperialism.

In connection with this the leading themes of the meeting were: *1.* The restoration and improvement of what has been wilfully destroyed; *2.* The readjustment of education to the post-war needs of the new cultural, political and social developments. At the first round table conference, Dr. Vlekke delivered an introductory talk on "Post-war reconstruction of education in Holland in relation to general educational problems." Dr. Vlekke observed that the chief post-war concerns would be to counteract the Nazi influences and to correct the former deficiencies. He pointed out that Dutch education was limited to school education. This had an advantage because the teachers as a class were strongly anti-Nazi, which kept Nazi influence outside the schools. In addition, even some of the defects of the educational system, *viz.* the over-emphasis on intellectual training, and the neglect of consistent physical education, became assets in the struggle against the national-socialist ideology. It aided to combat slogans and cheap generalizations. For the post-war period, Dr. Vlekke stressed the need for visiting scholars from the Allied countries. A general reform could be limited to details as before the war 25% of Holland's taxes was spent on education of which 80% was for elementary instruction. It would be advisable to introduce, as a new subject in the elementary schools, the study of civics. At the secondary schools the humanities should be stressed. The study of Latin should be rejuvenated by partly replacing the classical authors by those Dutch authors (Erasmus *et al.*) who wrote in that language.

The discussion centered around the pre-war prejudices against teachers and the teaching profession. Father Mommersteeg discussed the dynamic factors in Nazi education which appealed to youth generally and were lacking in Dutch education. He wished to counteract this by teaching democratic ideas and ideals in schools. Further participants in the discussion were Dr. A. J. Barnouw, Dr. Hromadka who mentioned the parallel situations in Czecho-Slovakia; Professor Dresden who considered it an omission that nothing had been said about the training of teachers and Mr. J. B. Orrick who told about the activities of the committee for international educational reconstruction in this country.

At the second Round Table Conference (Jan. 29th, 2:30 p.m.) Dr. N. A. C. Slotemaker de Bruine delivered an introductory talk on "Educational Problems in the Netherlands Indies." The speaker gave a survey of education in the Netherlands Indies until the Japanese occupation, the present situation and an outline of sug-

gestions for the future. In the Indies education was a fundamental factor in the meeting of Oriental and Western culture, which made for the necessity of a "dual" (*viz.*, oriental and occidental) educational system. After having discussed the schools of the 19th century (*viz.*, native Mohammedan religious schools; European schools; institutes for the training of Indonesian Civil Servants, 1st and 2nd class primary schools for Indonesians) Dr. SLOTEMAKER DE BRUINE pointed out that education gained true momentum since 1906, when the national oriental elementary school with a three years course was introduced. Different from the French (Indo-China) or American (Philippines) approach, instruction here was based on the local environment and the native language. Continuation and other schools provided facilities for higher elementary and vocational training. Besides, occidental elementary education, leading up to secondary and university training, was given in various types of schools for all different groups of the population. The Speaker pointed out that although illiteracy was declining it was still great, yet, 40% of the children of school-age (6–9) went to school, as against 38% in the Philippines. From 1915 to 1940 attendance at the vernacular elementary schools had increased with 400% and from 1939 on 800 of such schools were established annually. Dr. SLOTEMAKER proceeded to discuss the financial problems and the situation under Japanese rule. Although few reliable data are available it is certain that the Japanese are lowering the standards and consistently wiping out all Western influence. Dr. SLOTEMAKER asserted that the suggestions for the future must be seen in the light of the address of the Queen of December 6, 1942. A future "ten year plan" will be carried out by the Indonesian government itself. Mutual understanding and the development of solidarity among the different races will be one of the aims. Popular education will be spread throughout the Indies, as much as possible independent from the state budget. Malay as a compulsory subject will be introduced in the occidental curriculum.

Following this talk a lively discussion ensued in which participated Dr. F. H. VISMAN, Dr. P. HONIG, Professor RAYMOND KENNEDY, who pointed out that the Netherlands Indies educational system did not provide enough facilities for the training of Indonesian leaders, and Professor J. O. M. BROEK.

Falling outside the scope of the main topic of the conference, was an illuminating lecture by Dr. A. P. H. TRIVELLI, on "Experiences in the Region of Ultimate Knowledge." Starting with the famous inscription on the ancient Egyptian "Tabula Smaragdina," Dr. TRIVELLI traced the dialectic development of monistic thought through the ages and showed its significance for modern science.

At the business meeting it was decided to hold the next meeting at Yale University in the first part of July. The functioning executive committee, consisting of Professor A. J. BARNOUW, president; Professor J. A. C. FAGGINGER AUER, vice-president; Dr. B. LANDHEER, secretary; and Mr. WILLARD C. WICHERS, treasurer, was unanimously reelected. As additional vice-presidents were appointed: Dean M. TEN HOOR of Tulane University, Professor J. M. KOLTHOFF, University of Minnesota and Professor F. W. WENT, California Institute of Technology, Pasadena.

Dr. T. W. L. SCHELTEMA of the Library of Congress, Washington, D.C. submitted a plan for the reconstruction of Dutch Libraries.

The meeting was brought to a successful conclusion by a dinner, attended by His Excellency, Dr. A. LOUDON, Dean CHRISTIAN GAUSS, Professor J. B. WHITTON, Professor ALBERT VAN EERDE of Princeton University, Professor J. L. HROMADKA of the Princeton Theological Seminary, Professor ALBERT EINSTEIN of the Institute for Advanced Study and by many other notables. Professor A. J. BARNOUW presided at the dinner.

In his after-dinner speech, the Netherlands Ambassador asserted that in the past education had dealt too much with the history of power rather than the history of civilization, and instead of analyzing social and historical prejudices, it continued to present these same prejudices as historical or patriotic facts. What has developed historically can continue to grow only if it is based on justice. Dr. LOUDON stated that this principle would have to be applied to the Axis countries, but that the democratic peoples must also remember that vigilance is the price of liberty.

Earlier in the program Dean GAUSS remarked that post-war education will have to look at the future not at the past, for men make history — not history men.

A buffet luncheon was given by the University League in honor of His Excellency, Minister G. BOLKESTEIN, who at that time was in this country. The luncheon was held on Saturday April 8th at the Harvard Club, New York City and was attended by many distinguished guests and members of the League. Among those present were His Excellency, the Belgian Minister FRANK VAN CAUWELAERT, the Netherlands Consul General, Mr. T. ELINK SCHUURMAN, Dean E. GEORGE PAYNE and Mr. REINHOLD SCHAIRER of the U.S. Committee of Educational Reconstruction, Dr. J. A. GORIS, Director Belgian Information Center, Mr. H. DE WOLFE FULLER and Mr. JAMES M. CECIL of the Netherlands America Foundation, Dr. N. A. C. SLOTEMAKER DE BRUINE, Director of the Netherlands Information Bureau, Professor A. A. SCHILLER, Columbia University, Professor PETER DEBYE, Cornell University, Professor E. ADAMSON HOEBEL, New York University, Professor A. J. BARNOUW, Columbia University, Professor J. A. C. FAGGINGER AUER and Professor J. ANTON DE HAAS of Harvard University, Professor JAMES A. VAN DER VELDT, O.F.M., of St. Joseph's Seminary, Yonkers and many others. Professor BARNOUW welcomed the minister to this country on behalf of the League.

NETHERLANDS INFORMATION BUREAU,
NEW YORK CITY.

**International Aspects of the Protection of Coastal Fisheries** *: — Practically all countries bordering upon the sea have fishing grounds in the adjacent waters. Often their sea fisheries are the chief dependency of the coastal population. From remote times there has been an influx of fishermen from other countries to fishing banks of proved worth. Very often their attempts to share in the catch of greatly valued fish have been the cause of much friction, and have given rise to many and prolonged international conflicts.

With the rise of modern fishing methods of far

* S. A. RIESENFELD, 1942, Protection of Coastal Fisheries under International Law, Pp. 296 (Washington, D.C.: Carnegie Endowment for International Peace).

greater efficiency, combined with the use of swift, far-ranging motor vessels, these coastal fishing banks have become exposed not only to more intensive exploitation but to destruction. Conflicts have become therefore not only more frequent but also more serious.

Dr. RIESENFELD has studied the problems involved from the standpoint of international law, fully cognizant of the fact that at present there is no international law. There are three great sources for international law, which the author states are of increasing importance in the following order: — (*a*) text writers; (*b*) state practice; (*c*) international adjudications. To each of these a section of his book is devoted.

In Part I international legal theory is considered from the time of Roman law down to recent time (1930). References and quotations are profuse and thoroughly documented. From the time of GROTIUS, upon whom great emphasis is laid, a rather complete survey is made of the positions of 227 individual writers during the nineteenth and twentieth centuries. A chapter is also devoted to the private groups that have considered the matter, and to the international and national congresses dealing with it.

Part II is devoted to a survey of the practice of the following states: — Great Britain and members of the British commoi wealth; the European East Atlantic coast states; the Mediterranean states; the Baltic Sea coast states; the North Sea coast states; the American Republics, except the United States; the Far East; the United States. The Hague Codification Conference made plain that there is no universally recognized three mile rule. While many states generally adhere to the three mile rule, many others do not recognize it or do so only to a very limited extent. The author finds that no nation has always stuck to the three mile rule for all purposes. He finds that reasons of policy dictate the position of a nation on this matter, and that its position shifts with the particular interests involved. The coastal fisheries are too involved with questions of neutrality, naval and military policy and strategy, navigation, customs, and national politics to be considered apart or made the subject of a fixed international policy with definite space limits applicable to all and everywhere.

Part III takes up International Arbitrations, in so far as they deal with coastal fisheries. None of them face squarely the matter of protecting coastal fishing grounds by the adjoining state, and therefore have little value in deciding the limits and control of territorial waters.

A feature of the book is the foot-note translations of the many quotations in the text, in Dutch, French, German, Italian, Latin, Portuguese, and Spanish.

The fisheries are a great natural resource, and their protection and conservation are of essential importance. It is evident that their conservation and proper protection have been wanting in the past, and can never be brought about by adherence to the three mile rule, or any other rigid formula. Dr. RIESENFELD concludes that "coastal fishing grounds, owing to their primordial importance for coastal states and owing to the very immanent danger of their complete destruction resulting from the employment of piratical techniques by distant nations, can be adequately preserved only by control and exclusive exploitation by the coastal state." He adds that "international law must and does recognize the right to such control by the coastal state unless the vested and long standing rights of other nations are infringed. This seems to be the only way in which important food supplies for mankind may be preserved."

The author's conclusion is "if after the present war an international society and an international legal order should be resurrected, though probably in different form, the continued controversies which the coastal fishing grounds have caused under the old system should be studied to determine what should be done and what avoided in the future."

To this the reviewer, as a life-long student of fishes and the fisheries of the world, heartily agrees. The author deserves the thanks of fishery students and administrators and government officials for his painstaking and successful efforts to bring together and summarize everything of importance dealing with the subject, with such complete documentation.

On page 116 the author speaks of the International Conferences for the Regulation of Whaling as "probably the most successful international congresses," and on page 277, foot-note 5, says "the international regulation of whaling is probably the most successful attempt to protect a valuable species of maritime life by international coöperation." To this I cannot agree. Japan, which had become an important factor in Antarctic whaling, refused to enter the agreements of 1937 and 1938, paid no attention to restrictions, and made every effort to increase their catch of whales. As a matter of fact, the restrictions imposed and agreed upon by Norway, Great Britain, Germany, and other countries gave no appreciable protection to whales. Not until 1939 did Japan become a signatory to the agreement. Of course the war put an end to Japanese whaling, and the facts of Norwegian and British Antarctic whaling are concealed at present. We can scarcely tell how successful the agreement would have been, since it was in full effect but one season. Its real success was in getting all the whaling countries to sign an agreement, leaving to the future the enactment of restrictions that would really protect whales.

KARL BRANDT states (p. 100, "Whale Oil: an Economic Analysis," 1940), "it might be assumed that the ends of a conservative utilizatioy of the great marine resource could be achieved by such international coöperation. Unfortunateln the practical results do not justify any such assumption."

Presumably the results obtained by the commission for the conservation of the halibut fishery off Canada and the United States in the North Pacific, do not fall under Dr. RIESENFELD's definition of an international agreement. The moribund halibut fishery, under regulations worked out by the scientific staff of the commission, was restored to a healthy and profitable condition. This is the only example of a fishery resource having been rescued from destruction by international agreement. In his reference to it (pp. 262–263), Dr. RIESENFELD makes the point that this convention and the one on the Pacific salmon fisheries are "attempts of neighboring nations on the same continental shelf to protect and conserve common fishing grounds by treaty."

Another example of a successful international agreement for the rehabilitation of a vast vanishing marine resource is that on the fur seals of the Pribylov Islands. An agreement was finally

reached when the herd had diminished to about 5% of its original size, between the United States, Great Britain, Russia, and Japan. The results of this agreement have been very successful. However, it is scarcely germane to the scope of Dr. RIESENFELD's book.

On page 249 the author refers to the Japan Year Book of 1938–9 and "its very instructive chapter on Japanese fisheries," from which he quotes. Apparently few students and writers in this country are aware of the much more complete and authoritative volume on Japanese fisheries issued by The Japan Times and Mail. This 172-page work, published in 1940, is entitled Japanese Fisheries Industry 1939. (ALBERT W. C. T. HERRE, Stanford University, California.)

J. J. POLAK: **The UNRRA:** — On November 9, 1943, the United Nations Relief and Rehabilitation Administration (UNRRA) was brought into being when the representatives of forty-four nations signed the UNRRA agreement in Washington. Thus an agency was created to provide relief, in the form of food, clothing and other necessaries, for the populations in the areas liberated from the enemy and to take measures for the rehabilitation of their agriculture and industries.

The provisions of the UNRRA agreement were further implemented in the first meeting of the Council of that body at Atlantic City, New Jersey, from November 10 to December 1, 1943. In these three weeks the representatives of the member countries of this international organization worked out the broad principles for the provision of relief to any territory as soon as it had been liberated from the enemy.

The area of operations of the UNRRA falls into broad geographical regions: Europe and the Far East. The organization of UNRRA takes this fact into account. Under the Council, which is the highest policy-making body, there have been created a Committee for Europe and a Committee for the Far East. Their functions are to advise the Council with respect to relief policies and to inform it of the relief needs of these two areas. In each of these two committees the countries most directly interested are represented. Therefore, the Kingdom of the Netherlands has been appointed a member of both.

In addition, the Netherlands have been elected to the function of first vice-chairman of the Committee for the Far East. At present the Committee for the Far East is still holding its meetings in Washington, but it is planned that it will move to some place in the East as soon as conditions permit. By that time the head office in Washington will also establish an important branch office in the East to administer UNRRA relief activities in that region, in the same way that a European office has already been created in London.

The wisdom of treating the two regions to a large extent separately became quite clear at the conference in Atlantic City. In many respects there are important differences between the relief problems of the Far East and those of Europe. In the first place there is a difference in time. It is reasonable to expect that UNRRA will start large scale operations in Europe before it is able to do so in the Far East. For this reason the European relief task appeared to be the more urgent one, and most attention was centered on it. Secondly, and somewhat connected with the factor just mentioned, there was a great difference in the extent to which the preparation of relief plans had advanced. An Inter-allied Committee on Relief Requirements had been meeting in London for two years prior to the Atlantic City conference and had elaborated quite detailed plans concerning the relief needs of each of the allied countries of Europe. No such detailed preparations had as yet been made for the Far Eastern region as a whole, although the Board for the Netherlands Indies, Surinam and Curaçao in New York had prepared an extensive analysis of the relief needs of the various regions of the Netherlands Indies archipelago. A considerable amount of work will still be required to establish for the Far East common scales of relief requirements and to arrive at a general relief plan for this area.

Thirdly, in the policies of relief distribution it will be necessary to take into account the specific local forms of organization in the Far Eastern community, which are so different from those in Europe. As was stated in a memorandum prepared by the Netherlands Delegation at the UNRRA conference, the age-old structure of the Indian *desa* can and should be used as a link in the distribution of relief supplies.

It is important to realize that the Netherlands East Indies have a dual rôle with respect to relief. They will be not only relief claimants, but soon after liberation they will in their turn become an important source of relief supplies for other countries. Palm oil and copra are two commodities which the Netherlands East Indies can make available for export very shortly after liberation and which will be of great value in the face of a world shortage of oils and fats. The UNRRA, in the outline of its policies, has shown that it is fully aware of the necessity of utilizing to the utmost such facilities of a relief recipient to produce relief supplies.

To enable a country to fend for itself, rather than merely to provide it with relief supplies, is the ultimate aim of the UNRRA. Much stress has, therefore, been laid on its objective of rehabilitating the liberated countries. "Rehabilitation" has, it is true, been defined rather narrowly in order to prevent the limited resources of UNRRA from being consumed in large scale reconstruction or development programs, for which this organization was not created. But UNRRA will assist in the rehabilitation of the production of foodstuffs and other relief supplies. Thus one of its important functions will be the rehabilitation of agriculture, for which it will make tools, fertilizers, etc. available. Furthermore, UNRRA's activities will be directed toward the reconstruction of those industries which provide commodities that are directly needed for relief. Sugar mills are one example of such industries, and an example of particular interest to the Netherlands East Indies.

The activities of UNRRA go, however, beyond those just mentioned. It will also occupy itself with the repatriation of persons who, as an effect of the war, have been displaced — a function which is of relatively minor importance to the Netherlands Indies. Furthermore, UNRRA has created two divisions which will plan for and provide for the reconstruction of the medical services and of the welfare services in liberated countries in cooperation with the governments of the areas concerned and to the extent that UNRRA is re-

quested to do so. It is possible that particularly with respect to health work UNRRA will become of very great importance to the Indies.

In all its operations UNRRA will work in the closest coordination with both the military authorities and the government in each area. Acting in this way, UNRRA will have a very important task before it. The establishment of agreed relief requirements between various countries, the presentation of these combined requirements to the supply organizations of the United Nations, and the systematic distribution of relief supplies in all areas liberated from the enemy constitute a task which comes properly within the scope of an international organization and which UNRRA may be expected to perform effectively. Its subsidiary, but in many cases equally vital, functions contribute to providing for UNRRA a unique position for the first few years after the war, during which both the Netherlands and the Netherlands East Indies may hope to reap great benefits from this organization.

*Summary of Recent Activities*: — Since the above was written, UNRRA has moved from the planning to the operational stage. Prior to V-E Day, the scarcity of shipping and supplies permitted the Administration to ship overseas only 37,000 tons. Three months later, with the cessation of hostilities in Europe, UNRRA had delivered some 1,300,000 tons. The surrender of Japan made possible UNRRA's operations on a global scale. By the end of August 1945, UNRRA's shipments totalled 1,743,318 gross long tons, valued at $417,914,000 — almost entirely to those liberated countries in Europe which did not possess sufficient foreign exchange resources to purchase relief imports, and to which UNRRA was giving assistance: Greece, Yugoslavia, Czechoslovakia, Poland, Albania and Italy. In addition, some 5,000 UNRRA displaced persons specialists were aiding the Military in Germany in the assembling, caring for, and repatriating of United Nations nationals, of whom some 6,000,000 were found in the SHAEF areas of Germany. UNRRA doctors have been serving in Greece, Yugoslavia, Italy, UNRRA's Middle East camps, in displaced persons operations in Germany, and in China. UNRRA welfare specialists are at work in the above-mentioned areas, and welfare officers advise and aid Governments in organizing the handling of relief distribution to the needy and in providing institutional and communal care for children, the aged, and handicapped.

Up to V-J Day, UNRRA's activities in the Far East had been mainly of a preparatory character. UNRRA had an office in Sydney to serve the South-West Pacific Area, and one in Chungking to plan relief with the Chinese government. Now, with the China ports open, operations in that country will assume large proportions. In performing its task in that part of the world UNRRA has been assisted by the decisions of its Third Council Session in London in August 1945, which, among other important decisions, recommended a further contribution of the uninvaded nations, thus raising UNRRA's total present and prospective resources to about $3,600,000,000 and authorized the Administration to operate in Korea and Formosa.

In conclusion, it should be pointed out that while UNRRA was created as a service agency to assist in the rehabilitation of the economies of the United Nations, it is not expected to perform the whole job alone. Actually, UNRRA, in accordance with decisions by the Council, concentrated on assisting those nations lacking foreign exchange resources. As a result, the western European countries, such as France, Belgium and the Netherlands, are taking care of their own relief needs; the same applies to the liberated overseas territories of these nations.

Board for the Netherlands Indies,
Surinam and Curaçao,
Washington, D.C.

Horace Belshaw: **The Institute of Pacific Relations:** — The Institute of Pacific Relations is an unofficial and non-political organization, founded in 1925 to facilitate the scientific study of the peoples of the Pacific area. It is composed of autonomous National Councils in the principal countries having important interests in the Pacific area, together with an International Secretariat. It is privately financed by contributions from National Councils, corporations and foundations. The Institute, as such, does not advocate policies or doctrines and is precluded from expressing opinions on national or international affairs. It is governed by a Pacific Council composed of members appointed by each of the National Councils.

In addition to the independent activities of its National Councils, the Institute organizes private international conferences every two or three years. Such conferences have been held at Honolulu (1925 and 1927), Kyoto (1929), Shanghai (1931), Banff, Canada (1933), Yosemite Park, California (1936), Virginia Beach, Virginia (1939), Mont Tremblant, Quebec (1942), Hot Springs, Virginia (1945). It conducts an extensive program of research on the political, economic and social problems of the Pacific area. It also publishes the proceedings of its conferences, a quarterly journal *Pacific Affairs*, and many scholarly books and popular pamphlets embodying the results of its studies. The International Secretariat and Publications office is at 1 East 54th Street, New York 22, New York.

At the present time the National Councils, their National Secretaries and their addresses are as follows: Australian Institute of International Affairs, W. D. Borrie, Esq., 369 George Street, Sydney, Australia; Canadian Institute of International Affairs, Douglas MacLennan, Esq., 230 Bloor Street West, Toronto 5, Canada; China Institute of Pacific Relations, Liu Yu-wan, Esq., 6 Kincheng Villa, Chungking, China; Comité d'Etudes des Problèmes du Pacifique, Roger Levy, Esq., 54, Rue de Varenne, Paris VII, France; Netherlands-Netherlands Indies Council, Institute of Pacific Relations, J. F. Engers, Esq., 10 Rockefeller Plaza, New York 20, New York; New Zealand Institute of International Affairs, A. W. Free, Esq., P. O. Box 774, Wellington, New Zealand; Philippine Institute of International Affairs, Hon. Jaime Hernandez, 1617 Massachusetts Avenue, N. W., Washington, D. C.; Royal Institute of International Affairs, Ivison S. Macadam, Esq., Chatham House, 10 St. James's Square, London S. W. 1, England; U.S.S.R. Council, Institute of Pacific Relations, Dr. E. Zhukov, Pacific Institute, 14 Volhonka, Moscow, U.S.S.R.; American Council, Institute of Pacific Relations, Raymond Dennett, Esq., 1 East 54th Street, New York 22, New York.

The officers are: P. E. Corbett, Chairman; R. J. F. Boyer, Chiang Monlin, Paul Pelliot, F. H. Visman, Vice-Chairmen; K. C. Li, Finance; Grayson Kirk, Programme; Sir George Sanson, Research; Edward C. Carter, Secretary-General; and Horace Belshaw, International Research Secretary; Hilda Austern, Assistant-Treasurer.

The Ninth Annual Conference of the Institute held at Hot Springs, Virginia, from January 6th to January 17th, 1945 devoted its attention to these main questions:

(*1*) What were the most significant developments in 1944, in their bearing on relations between the United Nations and the prospects of establishing foundations for a durable peace and economic, social and political progress among the peoples of the Pacific?

(*2*) What will be the effects of defeat on Japan, what principles should determine policy in relation to Japan and how should these principles be given concrete expression?

(*3*) What economic problems will exist in the Pacific area after the war and how should these

problems be attacked so as to promote economic recovery and ensure continuing progress?

(4) In what way has the war affected cultural and race relations in the Pacific area, and by what means may these relations be improved?

(5) What problems are involved and what policies and methods should be adopted to promote the welfare of dependent peoples and assist them towards self-government?

(6) How should the organization of collective security be designed in the Pacific area in order to ensure a durable peace?

The discussions at the Plenary Sessions and round tables which devoted themselves to these topics are reported in the volume *Security in the Pacific* published in April of this year under the editorship of Dr. HORACE BELSHAW, Mr. T. A. BISSON and Mr. BRUNO LASKER.

A large number of data papers were presented for the Conference. During the Conference the International Research Committee in addition to approving a number of individual projects for research, many of which are to be conducted by National Councils, on the basis of grants from the International Research Committee formulated a research policy covering these main fields:

(1) Machinery for International Economic Collaboration with Special Reference to the Pacific Countries.

(2) Agricultural Rehabilitation, Reform and Development in the Western Pacific.

(3) Development of Political Autonomy in Pacific Dependencies.

(4) Effects of Military Occupation (both by the enemy and the Allies) on Pacific and Far Eastern Territories.

(5) Race Prejudice and Race Conflict as Factors in International Relations in the Pacific.

(6) Development of Public Administration and Training of Administrative and Technical Personnel in Dependent and Weak Territories of the Pacific Area.

In general the current policy of the Institute is to direct its attention during the next few years to international studies germane to the problems of peace-making and the maintenance of security, relief, rehabilitation and reconstruction in the Pacific area.

INSTITUTE OF PACIFIC RELATIONS,
NEW YORK CITY.

JAMES F. ENGERS: **Netherlands and Netherlands Indies Council of the Institute of Pacific Relations:** — The Netherlands and Netherlands Indies Council of the Institute of Pacific Relations was established in New York on August 25, 1942 to take over temporarily the duties of the organization of the same name in occupied Holland. The latter had been established in July 1934 and had a daughter organization in Batavia.

After the invasion of the Netherlands in May 1940, the Indies' organization took over and finally its functions were temporarily vested in the Netherlands and Netherlands Indies Council in New York. The work of the New York Council was characterized from the beginning as a temporary make-shift, organized for the purpose of having an adequate representation of the Netherlands and the Netherlands Indies in the affairs of the Institute of Pacific Relations, and also to lend a hand in the publication of works on the Netherlands Indies of a more scientific character which could not be published on a commercial basis.

The Council took upon itself the task of providing representation from the Netherlands and Netherlands Indies to the Eighth International Conference of the Institute of Pacific Relations at Mont Tremblant. Members of the delegation under the chairmanship of the late Raden L. DJAJADININGRAT were: N. A. J. DE VOOGD, Lt. Col. C. GIEBEL, Dr. G. H. C. HART, W. P. HASSELMAN, Dr. P. HONIG, H. JACOBSON, P. H. W. SITSEN, Dr. J. VAN BEUSEKOM, J. H. WARNING, R. A. K. WIDJOJOATMODJO, with J. F. ENGERS s Secretary.

The following documents were submitted to this conference: Nationalism in the Netherlands Indies, by CHARLES O. VAN DER PLAS; The Industrial Development of the Netherlands Indies, by PETER H. W. SITSEN; Educational Developments in the Netherlands Indies, by LOEKMAN DJAJADININGRAT; Intensive rural hygiene work in the Netherlands East Indies, by J. L. HYDRICK; Towards Economic Democracy in the Netherlands Indies, by G. H. C. HART; The Netherlands Indies and their Neighbors in the Southwest Pacific, by G. H. C. HART.

During the conference, the late Dr. G. H. C. HART was elected a Vice-President of the Pacific Council, the governing body of the Institute of Pacific Relations.

Meanwhile a Research Committee has been preparing a number of monographs to be presented to the English-speaking public. Thus far the following have been published: Towards Economic Democracy in the Netherlands Indies, by Dr. G. H. C. HART; Industrial Development of the Netherlands Indies by PETER H. W. SITSEN; From Illiteracy to University, Educational Development in the Netherlands Indies, by Raden L. DJAJADININGRAT; Mining in the Netherlands East Indies, by ALEX L. TER BRAAKE.

In October 1945 Querido, Inc., in coöperation with the Council published "Indië in de Branding" by J. F. ENGERS, with a preface by Dr. F. H. VISMAN, a survey in the Dutch language of recent developments in colonial thought.

The Committee has also been instrumental in having a number of articles and book reviews published in Pacific Affairs and the Far Eastern Survey.

Preparatory to its Ninth Conference, the Institute of Pacific Relations held an interim conference at Atlantic City, N. J. in January 1944, at which a small delegation headed by the then chairman, Dr. P. HONIG, represented the Netherlands and Netherlands Indies Council. Finally the Council sent the following delegation to the Ninth Conference of the Institute of Pacific Relations, held at Hot Springs, Va., in January, 1945: Dr. F. H. VISMAN, Chairman, Dr. P. HONIG, Dr. D. CRENA DE JONGH, Raden M. M. S. N. DJOEMENA, W. P. HASSELMAN, J. HOVEN, H. JACOBSON, S. I. KAHN, Rear Admiral J. E. MEIJER RANNEFT, Colonel R. ROOS, and N. A. J. DE VOOGD. J. F. ENGERS again served as secretary. Here the delegation submitted the following three documents: Relief, Rehabilitation and Economic Development in the Netherlands Indies, by PETER H. W. SITSEN; The Provisional Government of the Netherlands East Indies, by Dr. FRANS H. VISMAN; and Mining in the Netherlands East Indies, by ALEX L. TER BRAAKE, mentioned above.

During the short time of its existence, the

Council has been very active in promoting a better understanding of the Netherlands Indies, especially of course at its proper place, the Institute of Pacific Relations. The organization has, however, been extremely unfortunate in losing through death, three of its most active members: Dr. G. H. C. Hart, Raden L. Djajadiningrat and Peter H. W. Sitsen.

At this moment the following are members of the Board: Dr. F. H. Visman, chairman, Dr. P. Honig, vice-chairman, Mr. H. Jacobson, honorary secretary, Mr. Jan Hoven, treasurer, Raden M. M. Soeria Nata Djoemena, Dr. W. P. Hasselman and Dr. N. A. C. Slotemaker de Bruine. Mr. J. F. Engers serves as executive secretary.

Dr. Visman was recently elected a vice-president of the Pacific Council of the Institute of Pacific Relations.

As soon as conditions permit the functions of the Council will revert to the appropriate organs in Holland and the Indies. It is expected that at that time the New York organization will only remain as a local agency of the Netherlands and Netherlands Indies Council.

Board for the Netherlands Indies,
Surinam and Curaçao,
New York City.

Natalie Gurney: **The Southeast Asia Institute** (*formerly*, the East Indies Institute of America) **and its Activities**: —

*Date founded:* July 31st 1941.

*Board of Directors:* Adriaan J. Barnouw, President; Ralph Linton, Margaret Mead, Vice-Presidents; A. Arthur Schiller, Treasurer; Jan O. M. Broek, Edwin R. Embree, Rupert Emerson, Evett D. Hester, Claire Holt, Raymond Kennedy, F. H. Visman, and John K. Wright, members of the board; Robert Heine-Geldern, Research Associate, and Natalie Gurney, Executive Secretary.

*Membership:* 281, including as Active (Professional) Members most of the scholars and specialists in the United States whose work relates to Southeast Asia, as well as some Supporting Members, and a few honorary, corresponding, associate and life members, who are generally interested in the area. — *Annual dues*: Active (Professional): $3; Supporting: $10; Life: $100. — Apart from individuals, Supporting Members include: American Geographical Society, American Museum of Natural History, Arnold Arboretum, Buffalo Museum of Science, Columbia University, Coolidge Foundation, Denver Art Museum, Viking Fund, and Yale University. — *Financed by*: Grants, donations and membership dues.

*Objectives:* (*1*) To stimulate or conduct scholarly studies and research relating to the Malay Archipelago, the Malay Peninsula, the Philippines, Burma, Siam and French Indo-China.

(*2*) To serve as a bond of union among scholars and cultural institutions in the United States and in Southeast Asia for purposes of collaboration and coördination of information and research.

(*3*) To promote in the United States better knowledge of Southeast Asia, its cultures and peoples.

(*4*) To coöperate in furnishing scholarships and fellowships and to extend any other aid to students of Southeast Asia and its culture and to students from Southeast Asia who wish to study in the United States.

(*5*) To publish and to encourage the publication of books, pamphlets, periodicals, and articles dealing with Southeast Asia.

*Activities:* In addition to the research projects outlined below, the Institute is developing five services:

(*1*) A research service for scholars and institutions.

(*2*) A research and information service for government agencies.

(*3*) Services to publishers in examining and advising on manuscripts presented to them, which deal with Southeast Asia.

(*4*) An extensive general educational service.

(*5*) Services of all kinds to its own members, including regular bi-monthly dinners where discussions are opened by specialists in the various fields.

Research Projects and Publications

*Bibliography;* A bibliographical card index on Southeast Asia is being built up, arranged by regions and subjects. A selected Bibliography on Southeast Asia of about 1500 titles has been prepared in coöperation with the American Council of Learned Societies, and is to be published by the latter.

*Survey of Studies on Southeast Asia at American Universities and Colleges:* This Survey, published August, 1943, has been distributed to all organizations, institutions and learned societies interested in Southeast Asia, as well as to American universities and colleges. Copies are available, upon request.

*Specialists and Lecturers on Southeast Asia:* In connection with the above Survey, the Institute has compiled and recently published a 75-page booklet of lecturers on Southeast Asia and adjacent regions, giving full details of lecturers and the subjects of their proposed courses and lectures. Copies of this are available, upon request.

The Institute is also building up a file of specialists in various fields of study relating to Southeast Asia. It has coöperated with other organizations in building up their files of experts with specialized regional knowledge of Southeast Asia.

*List of Monuments in the Netherlands East Indies:* A comprehensive list was prepared of monuments in the Netherlands East Indies which should be protected by reason of their cultural value or their religious importance for the local population. The actual locations of these monuments were subsequently indicated on maps.

*Adat Law:* The Institute, in collaboration with the Netherlands Information Bureau, is producing an edited and annotated English translation of "Beginselen en Stelsel van het Adatrecht," by Dr. B. ter Haar, which is an introduction to Indonesian Customary Law, *Adat*. Dr. A. Arthur Schiller and Dr. E. Adamson Hoebel are in charge of this project, which will be the first work ever published on the subject in the English language.

*The Kalingas, Their Institutions and Custom Law*, by Dr. R. F. Barton: A mimeographed edition was produced with the help of the Department of the Interior, and a number of copies distributed to government agencies, libraries and scholars.

*Animistic Beliefs and Religious Practices of the Javanese:* The Institute translated and edited a collection of papers on this subject, based on lectures given in Sumatra by Raden Supatmo, for the benefit of administrators of the United States

Rubber Company there. Mimeographed copies are available, upon request.

*Prehistoric Research in Indonesia:* The Institute's Research Associate has recently completed this article, which is published in the present volume.

*Other Publications:* The Institute has coöperated in the publication of the following: "The Structure of Netherlands Indian Economy," by Dr. J. H. BOEKE (Institute of Pacific Relations, 1942), and "The People of Alor: A Socio-Psychological Study of an East Indian Island," by Dr. CORA DUBOIS (University of Minnesota Press, 1944). The November 1942 issue of the "Far Eastern Quarterly" contained a series of articles on Southeast Asia contributed by members of the Institute. The Institute also organized the February 1945 issue of the "Far Eastern Quarterly" and chose as the subject "The Philippines"; copies are available, upon request.

*Exhibitions:* Several exhibitions have been organized by the Institute, for example: "Design and Techniques in Textiles of the East Indies," New York, from January 22 to March 10, 1942; an Exhibition on the East Indies shown in 1942 at the Library of Congress; and an Exhibition on the Arts of the East Indies, at the Century Association, New York, from December 10, 1942 to January 8, 1943. The Institute was instrumental in helping to build up the permanent collection of Indonesian Art at the Buffalo Museum of Science.

*Bi-Annual Report 1941–43:* Available upon request, and giving summary of activities, details of membership, financial statements, etc.

*Future Work:* Apart from development of the research services mentioned above, the Institute is working on a detailed program of suggested post-war research in Southeast Asia. It is hoped that this will result in the publication of a "Guide for Research and Study on Southeast Asiatic Cultures and Peoples," and will be composed of 16 separate research guides on the following areas: Assam; Burma; Siam; French Indo-China; British Malaya; Andaman Islands and Nicobar Islands; Sumatra and adjacent islands; islands west of Sumatra; Java and Madura; Bali and Lombok; Lesser Sunda Islands; Borneo; Celebes and adjacent islands; Moluccas, Southwest and Southeast Islands; Philippines; Formosa; — each guide to deal with the following subjects: anthropo-geography, physical anthropology, languages, archaeology, history, ethnography and ethnology, religion, literature, culture contacts and applied anthropology, main centers of study, bibliography. The Institute believes that planned research is urgently needed, if, during the accelerated process of cultural levelling likely to take place in the post-war period, important information is not to be lost for science forever. It is hoped that the suggested research program may also contribute to future international collaboration in the Southeast Asiatic field.

A memorandum on the above project, written by Dr. R. VON HEINE-GELDERN, will be published in the December 1945 issue of the "American Anthropologist, under the title: "Research on Southeast Asia, Problems and Suggestions."

*Scholarships:* The Institute's future plans of development call for a series of scholarships to be given to students from or interested in Southeast Asia.

THE SOUTHEAST ASIA INSTITUTE,
15 WEST 77TH STREET,
NEW YORK CITY.

B. LANDHEER: **The Netherlands Studies Unit at the Library of Congress:** — The Studies Unit started to work on June 1, 1942, under the directorship of the author, while Dr. A. VAN DEN BOSCH functioned as consultant for the Indies and Miss JANE FOSTER as secretary. At that time the following schedule of activities was arranged with the Library as pertaining to the realm of the Netherlands Studies Unit:

(*1*) To assist the Library in building up and improving its collections of Dutch and Dutch East Indies material.

(*2*) To function as a reference unit in the field of information pertaining to the Netherlands, the Netherlands East and West Indies.

(*3*) To prepare a number of publications of a bibliographical nature concerning the same subjects.

As most of the work has been on this last subject, progress in this field will be reported in the first place. At the time of the creation of the Netherlands Studies Unit, one project was already under way, namely the preparation of a "Guide and Legal Bibliography of Dutch Law." For this undertaking an editorial committee was formed about a year ago, consisting of Dr. JOHN F. VANCE, Law Librarian, Dr. A. VAN DEN BOSCH, Dr. E. VAN SAHER and the author.

At the request of the Studies Unit, Mr. SCHELTEMA of the Library of Congress is preparing a *Survey of Dutch Bibliographies* which is expected to prove very useful to the various government agencies which are working on the Netherlands and the Netherlands East Indies. This survey is scheduled to be finished by the end of 1945.

*Bibliographies on the Netherlands, the Netherlands East Indies and the Dutch in the United States.* — A considerable amount of bibliographical material has been collected under these various headings, to a total at present of approximately 15,000 items. As it became evident that there is an urgent need in the various government agencies and also in general for a selective bibliography of the Indies, it was decided to concentrate on this and to proceed later with the collection of bibliographical material on the Netherlands and the Dutch in America. The first part of the East Indies bibliography appeared a few months ago.

In the other major fields of activity the Netherlands Studies Unit has as yet not been able to make much progress. As far as the assistance to the Library in building up its collections on the Netherlands and the Netherlands East Indies is concerned, the war has made extensive operations impossible. It has only been possible to give information about material which the Netherlands Government has available and to acquire the acquisition lists of the Library of the Netherlands Information Bureau which sometimes contain unusual material.

Contacts were established with the various government agencies and in many cases information was given on requests from these agencies or from the general public. Information was given to U. S. Army, U. S. Navy, Board of Economic Warfare, Strategic Services, U. S. State Department, U. S. Treasury, Netherlands Embassy, Netherlands Economic Mission, Netherlands Military Mission and a number of private persons and organizations. Information was given about topics such as conditions in occupied Holland, about available Malay and Javanese handbooks, about literature pertaining to various aspects of the Indies, health conditions in the West Indies, etc.

An exhibition was organized of East Indies Art in the main lobby of the Library. It displayed unusual manuscripts against a setting of batiks, watercolors and photographs. The exhibition received much attention in the press and remained open for two months. Public interest in the exhibition was considerable.

A number of lectures were organized by the present staff: Dr. B. LANDHEER, Consultant, Miss E. VAN AALTEN, Assistant in charge, and Mrs. MOORE, Secretary.

LIBRARY OF CONGRESS,
WASHINGTON, D.C.

**Coolidge Foundation:** — Some mention may well be made in this volume of the activities of the Coolidge Foundation. This Foundation was established as a charitable trust under the laws of California on September 19, 1941. It is governed by a Board of Trustees who are assisted by Scientific Advisors, each representing a principal field of interest. The present Trustees are WILLIAM BURDET, HAROLD J. COOLIDGE and J. THEODOR CREMER. The Foundation's address is 70 Pine Street, New York City. During the past four years grants have been made by the Foundation covering a wide range of activities in the field of science and research. Recipients of grants include Harvard, Duke, and the University of California, the Library of Congress, the Foreign Policy Association, and The Southeast Asia Institute (formerly East Indies Institute of America). As it enters its fifth year, the Foundation is directing its activities towards Southeast Asia including the Philippines, Burma, Siam, Indo-China, Malaya, and the islands of the Netherlands East Indies. Fellowships are being offered in the field of tropical medicine, public health, tropical agriculture, nutrition, and conservation to enable scientists to work in Southeast Asia. Research will be sponsored in such a way as to assure maximum benefits to the people of the areas concerned as well as the advancement of scientific knowledge.

C. L. MANTELL: **Activities of the Netherlands Indies Laboratories:** — In 1933 the *Nederlandsch Indische Vereeniging voor den Handel in Gommen*, an organization comprising the shippers and exporters of natural resins in the Netherlands Indies, began their support of a research program at the laboratories of the Hilton Davis Company in Cincinnati, Ohio. This research work concerned the obtaining of fundamental information and technological application data on Damar, Copal, East India, Macassar and related resins which were being shipped to the United States. In 1934 this group asked Dr. C. L. MANTELL to direct the work, he having previously assumed the direction of a related project for the American Gum Importers' Association which was an organization of those firms in the natural resins business in the United States. In the fall of 1936, Dr. MANTELL designed laboratories in Brooklyn for the two organizations coöperating under a single directing head. This was the beginning of the Netherlands Indies Laboratories. The publications in the scientific and technological journals resulting from the work constitute the major source of information on the natural resins. In 1940 a separate Netherlands Indies Laboratories was set up to intensify the work on resin processing and preparation of the same for markets so as to achieve wider distribution. From 1940 on, the activities of the Netherlands Indies Laboratories were carried on in the interest of the "Nederlandsch Indische Vereeniging voor den Handel in Gommen" and the "Harsen Centrale" until the end of 1942, at which time the activities were transferred for the interest of the Economic, Financial, and Shipping Mission of the Kingdom of the Netherlands.

The laboratories coöperated with the Laboratorium voor Scheikundig Onderzoek at Batavia, Java, and the Department of Economic Affairs of the Netherlands Indies, as well as the Netherlands Indies Trade Commissioner for the United States in New York.

The publications resulting from the work of the laboratory constitute the major sources of information on the natural resins. A 500-page book entitled "The Technology of Natural Resins" by C. L. MANTELL, Director, and C. W. KOPF, J. L. CURTIS, and E. M. ROGERS, associates of the Netherlands Indies Laboratories, was published by John Wiley and Sons, Inc., 440 Fourth Avenue, New York, and Chapman and Hall, Limited, of London in 1942. Chapters dealing with the Netherlands Indies resins have been written for the standard reference works like GARDNER's "Physical and Chemical Examinations of Paints, Varnishes, Lacquers and Colors," published by Henry A. Gardner Laboratories, Institute of Paint and Varnish Research, in Washington; MATTIELLO's "Protective and Decorative Coatings," published by John Wiley and Sons, Inc.; ROGERS' "Manual of Industrial Chemistry," sixth edition, published by D. Van Nostrand Company, New York; SIMONDS and ELLIS, "Handbook of Plastics," as well as various encyclopedia, tables, collections of information, and miscellanea.

During the war period of World War II, the laboratory has served as a reference and information source for various governmental agencies, such as the War Production Board, the Office of Scientific and Research Development, The National Research Council, and similar agencies. In 1943 in connection with Mr. C. VAN STOLK of the Netherlands Government Food Purchasing Bureau, an investigation was carried on in connection with the debittering of soy beans and the preparation of soy bean flour for bread and related foods. This included patent studies, laboratory studies, and baking of various foods.

Later on market studies were made in connection with the competition of synthetic resins as well as natural resins from sources other than the Netherlands East Indies.

At various times Dr. MANTELL has delivered papers before the different technical societies, Production Clubs, and users of the product, as well as making tours of portions of the country with men like Dr. D. R. KOOLHAAS, Mr. C. VAN DE KOPPEL, Dr. P. HONIG, and has been visited by businessmen, exporters and importers and other personnel from the Netherlands Indies as well as consumers in the United States. The laboratory has served as a development, research, information, and technological source concerning Netherlands Indies exports of agricultural and forestry products of the type designated as the natural resins, and has served as a consultant agency to various American groups to further the business of the natural resins. In the beginning there was little of specification and a tremendous

amount of secrecy. Now there are specifications, processing, technology, uses, new applications, and literature of an authoritative source readily available.

NETHERLANDS INDIES LABORATORIES,
NEW YORK CITY.

EARL H. MYERS: **A Fisheries Program for the Netherlands East Indies**: — The establishment of new fisheries and methods of processing sea food products is a recognized must in the post-war planning of the Netherlands East Indies. This need arises from the fact that the density of populations on Java and Madoera and the high value of export agricultural produce makes it economically unsound to feed more domestic animals than are needed to utilize those products of the land that are unfit for human consumption. The deficiency in animal proteins that results must be made up either by locally produced fisheries products or at the expense of foreign exchange.*

Thus far attempts made to increase the take of fish and the development of methods of processing sea food products has been centered in the Java Sea area in the vicinity of Batavia and Soerabaya. Until recently non-coastal people have been forced to depend upon dried, salted, or otherwise preserved marine fish because of the expense and difficulties involved in marketing fresh fish under tropical conditions.

*Work of the Sea Fisheries Laboratory.* — To overcome this situation, the Sea Fisheries Laboratory at Batavia purchased and equipped a large diesel powered boat with facilities for icing fish as they were delivered on board. The method used was to follow the native fishing fleet to the reef areas in the vicinity of the Thousand Islands, and after loading and icing the fish taken, to deliver them to Batavia where they were sorted, re-iced, and shipped to Buitenzorg, Bandoeng and other points in the interior for distribution. This venture proved a financial success but unfortunately, the scattered nature of the fishery made it uneconomical to operate more than one boat in this service.

As an outgrowth of this project a fleet of nine small diesel powered trawlers also equipped with icing facilities was established over a period of several years. This venture, financed in part by the Sea Fisheries Laboratory but operated by private individuals using native crews proved a success and additional trawlers were planned, two of which were under construction when Java was taken. Although these two projects were providing fresh fish in good condition to a select market, the selling price was prohibitive to those of modest means, and the limited supply made but a slight contribution to the overall needs of the industry.

In addition to the pick-up boat and trawlers, three canneries were established which depended upon local native fisheries for the delivery of fish. Unfortunately the supply of fish proved inadequate in each instance and the canneries closed. Had these canneries depended less upon migratory fish, and operated power boats, they would have had a better chance of success. However, the cost of containers, and processing, would have made the cost of the product prohibitive to those who most need additional protein in their diet, but might have supplied a limited market.

*Productivity of the sea.* — A major factor to be considered in the planning of post-war fisheries in this area is the fact that the Java Sea can never be made to yield more than a fractional part of the fisheries products required by the people of Java and Madoera. This sea is a shallow, relatively stagnant body of water in which plant organisms remove the nutrient salts as rapidly as they are made available through the decomposition of organic matter and other agencies. These plants in turn either directly or indirectly provide food for all of the animals living in the sea including the fish. Because of time lapse in this nutrient salt, plant, animal cycle, most of the phosphates and nitrates are locked at all times in the substance of the plants and animals either living or decomposing on the bottom. It is true that some enrichment of the nutrient salt content of the water takes place near the Indian Ocean entrances to the Java Sea and across the Soenda shelf from the deeper Flores Sea, but the sparcity of fish both local and migratory is suggested by the rare occurrence of large sharks in the Java Sea except in the vicinity of the Straits.

In the deeper oceans there is a reserve of nutrient salts at depths below that at which plants are able to thrive and under certain conditions these nutrient rich waters become mixed with the impoverished surface water, therefore the oceans especially in coastal areas are capable of supporting vast populations of marine organisms, including fish, compared with those of a shallow nearly land-locked sea.

*Prospects for the future.* — Because of the limited productivity of the Java Sea it is essential that new and more distant fisheries be developed. Upwelling or the mixing of the deeper nutrient rich water with the impoverished surface water takes place along the west coast of Sumatra. This suggests the probable occurrence of rich feeding grounds for both migratory and local fish populations. To fish these exposed coastal waters with its heavy ground swells and occasional storms, larger boats and heavier equipment are required than that used by local native fishermen. Further it will be necessary to equip special boats with a combination icing and mechanical means of refrigeration for delivering the fish to the larger centers of population or better, subsidizing mother ships capable of processing the fish on board. Before attempting such a program, it would be necessary to thoroughly investigate the potential productivity of the fishery. Other regions that should also be explored include Celebes, and the Moluccas. In 1940 plans were accepted for the construction of a sea going research vessel suitable for this work.

In the light of past experience and the prospects for the future the post-war plans for the Sea Fisheries program should include:

*Proposed program.* — (*1*) The subsidizing of government operated pick-up boats equipped with combined icing and mechanical refrigeration that would follow the native fishing fleets to the reef areas and deliver the fish taken to railroad terminals for shipment to the interior.

(*2*) Re-establishment of small fleets of diesel trawlers equipped for icing fish. These boats to be operated privately from Batavia and Soerabaya, but financed through government aid.

* For statistical data on the sea fisheries of the Netherlands East Indies see the 1939 report of the "Institut voor de Zeevisscherij te Batavia."

(*3*) The making of a survey for the purpose of locating new fisheries in more productive areas possibly off the west coast of Sumatra, the Celebes and Moluccas.

(*4*) The investigation of methods of processing fish so that they will retain their food value, keep well under tropical conditions, and be acceptable to native people. These methods should so far as possible be adaptable to use on board a mother ship that would be attached to a fleet of smaller fishing boats. Although native people process fish by methods that destroy the identity of the raw material, the time and expense required to educate these conservative people to new products should be considered in the processing methods investigated for use in the immediate future.

(*5*) The establishment of a fisheries school, possibly at Batavia where carefully selected native boys from favorable areas would be trained in improved methods of fishing, including the use of deep-water power operated gear. Immediately prior to the outbreak of hostilities, a similar school was being successfully operated at Singapore, where the boys were taught fisheries methods from the making and tanning of fish nets to the use of navigation charts and instruments.

(*6*) Re-establishment of research in marine biology at Batavia, to include the study of fish migrations, spawning seasons, spawning grounds, ecological relationships and conservation methods. Similar studies should also be made on invertebrates including shrimps, spiny lobsters, and shell fish. There is also the problem of conserving and possibly re-stocking the sea turtle fishery.

(*7*) The research on sea fisheries should be correlated with a sound Oceanographic program that would provide a better understanding of the influence of water movements on the fisheries, the role of the nutrient salt cycle under tropical conditions, and the plankton cycle in the sea.

(*8*) The granting of foreign fellowships to students with an adequate background in the basic sciences related to this program, so that they could study in foreign oceanographic and fisheries schools and observe at first hand those methods that have proven sound in other regions as regards fishing, processing and marketing fisheries products.

(*9*) With the return of peace, English will be the universal language of science, and most papers of international interest will be published in that language. Therefore, it will be advisable to keep this in mind in establishing reference libraries. All reports of international interest should be published in English and recognized international systems of recording and analyzing data should be used.

*Conclusions.* — The problem of feeding the people of the Indies will soon be urgent and little help can be expected from the outside. Locally produced carbohydrates should be adequate for subsistence, but the lack of imports of fisheries products and the probable depletion of local fishing fleets, make the fisheries problems of immediate concern. Many types of war craft will soon be available that can be reconditioned for fisheries work and may be had at a fraction of the cost of new construction. Should we fail to take advantage of the present situation and have boats ready to operate as soon as conditions permit, the results may be unfortunate.

HOPKINS MARINE STATION,
PACIFIC GROVE, CALIFORNIA.

L. RUTTEN: **An Atlas of the Netherlands Indies*:** — In July, 1938, was published an *Atlas van Tropisch Nederland*, which is undoubtedly a publication of great importance both for the people of the Netherlands as for foreigners interested in our Overseas Territories. At the International Geographical Congress held in Amsterdam last July it immediately attracted much attention.[1]

The publication of this work is due in the first place to the initiative of the Royal Netherlands Geographical Society. As early as 1909 the Board of this society conceived the plan of bringing out an atlas of the tropical territories of the Netherlands. From 1916 to 1920 a committee appointed by the society collaborated with two publishers on the general outline of the proposed work, but owing to the great expense involved, the plan had to be given up. In 1925 a new committee was formed, and in 1928 it became possible for the Topographical Service of the Netherlands Indies to undertake the printing of the maps and charts prepared under the auspices of the committee in collaboration with a number of experts. As a result of this co-operative activity the atlas has appeared as a joint publication of the two institutions named.

No particular purpose would be served by our listing the names of all the industrious committee members and experts who contributed to the production of this monumental work. It would not be right, however, not to mention some of these. For, as a matter of fact, the book's appearance in 1938 is due to the enthusiasm and energy of Colonel J. LUYMES, the chairman of the second atlas committee, and of Dr. A. PANNEKOEK, the geographical expert attached to the Topographical Service.

In the course of the last century several atlases of the Netherlands East Indies were published. The best known of these is the large one compiled by J. WM. STEMFOORT and J. J. TEN SIETHOFF, and published at the Hague by the Topographical Institution in 1885. A new up-to-date edition of this work was issued in 1907 by the Topographical Service at Batavia. However excellently it fulfilled requirements at the time of its appearance, this work cannot stand comparison in any respect whatever with the present volume. It is true that the maps in the earlier atlas are produced on a larger scale than those in the recent publication, but the last three decades have added enormously to our knowledge of the Archipelago (we need only remind the reader that in 1907 the interior of Celebes and New Guinea was not nearly so well known as it is now) and, furthermore, the same period has meant a notable advance in cartographical technique generally and, for the N. I. Topographical Service, a marked progress in craftsmanship and experience, which resulted in the very fine topographical maps of the East Indies that constitute the basis of many maps in the Atlas. The outcome is that, although the new maps are on a smaller scale, they are much more useful and much truer to fact than the older ones. The 1907 atlas includes practically no "scientific maps"; as a matter of fact there were only a few maps of this sort extant at the time, all dealing with Java (languages, roads, geology, etc.). With the 1938 publication the case is different; here we find a large number of maps illustrating the achievements of different branches of science, which all help to constitute the work what its sub-title claims it to be — a scientific atlas. The compilers' intention of making the appeal of the atlas as nearly as possible universal is clearly expressed in the Preface:

"The Society has tried to fulfil the purpose of making an atlas partly for general practical use and partly in order to give a survey of the outcome of a number of sciences and also of social and economic conditions in so far as they are to be fitted into cartographic representation of the size selected and the scale used."

The object of the publication being as indicated in the above introductory words, it would seem appropriate in the present review to endeavour to point out in what respects the atlas may be useful to foreigners interested in the Netherlands Overseas Territories.

* Reprinted from *Bull. Col. Inst. Amsterd.* 2:83-91 (1939).

[1] The official title of the atlas is, as stated, *Atlas van Tropisch Nederland*; it is published by the "*Koninklijk Nederlandsch Aardrijkskundig Genootschap* in samenwerking met den *Topographischen Dienst in Nederlandsch Indië*," 1938. Copyright. The book may be obtained from the last named organization at Batavia, and in Europe from Martinus Nijhoff, the Hague. The price is sixteen guilders.

As remarked above, a number of the maps included in the volume are intended to appeal to the general public. Regarding this group the following may be said:

Anyone who does not fully realize the exact geographical position of the Netherlands East and West Indies, will find map 1 — a map of the entire globe — instructive; map 2 presents the East Indian Archipelago in its immediate surroundings; on map *30a* we find Netherlands territory in America, while *31b* shows the Leeward Islands in relation to Venezuela. Maps 1, 2 and *30a* have been brought up to date to the year 1937 and include data regarding the most important lines of communication by sea, air and land (shipping lines, airways, railways, telegraph lines and radio stations). It is noteworthy how comparatively numerous the latter are in the East Indies (62 broadcasting and receiving stations, and 22 which only receive), as well as in Guiana and the West Indies (9).

The strictly topographical or chorographical maps are to be found on sheets *12b*, 13 and 14 (Sumatra, 1: 1,500,000; the sheets overlap); 20, 21 and 22 (Java, with Bali and Lombok, 1 : 750,000; slightly overlapping sheets); 25 (Netherlands Borneo, 1 : 2,500,000); 26 (Celebes, 1 : 2,000,000); 27 (the remaining Lesser Sunda Islands, 1 : 2,000,000); 28 and *29a* (Southern and Northern Moluccas, 1 : 2,000,000); *29b* (New Guinea, 1 : 3,000,000); *30b* (Surinam, 1 : 2,000,000); and *31b* (Netherlands Antilles, 1 : 300,000). From the above it is evident that the maps are not all drawn to the same scale — no doubt in the very first place because the subjects represented vary so much in size. But as it happens, the scale varies not only inversely as the size, but also directly as the importance of the territory dealt with. New Guinea, for instance, is drawn to the smallest scale, Java to the largest one. The only exceptions are the Netherlands Antilles, which although not so important have been drawn according to an extra large scale on account of their diminutive proportions.

In spite of the comparatively small scales used, these maps present an enormous wealth of detail and are, in addition, extremely clear. This combination of clearness and detail is largely due to the excellent way the relief is brought out. The sub-marine relief around the islands is indicated by graded shades of blue which increase in colour with the depth of the seas or oceans. In all these maps the grades adhered to are as follows: 0—200 metres, 200—1000, 1000—2000 metres and so on. The orographic relief is indicated by variously tinted zones of altitude outlined by isohypses and shaded in order to bring out further details. The grades adopted are not uniform throughout the work. On the sheets dealing with the Western portion of the Archipelago we find the isohypses at 100, 500, 1000, 1500 metres and so forth. In the Eastern part we find them at 100, 750, 1500, 2250 metres, etc., and in New Guinea at 100, 1000, 2000, and so on. This combination of colour and shading makes the relief stand out with great distinctness, though with marked exaggeration. It is a pity that a given zone of altitude is not indicated by the same tint on all the maps; on the other hand it is a satisfaction to note that the tints used in the later maps are clearer and more vivid than those found on the earlier ones. Colours are also used to indicate railways (black), main roads (red) and rivers (blue). Besides the principal maps we find on the "topographical sheets" a number of small accessory maps of some of the most important towns (Padang, Palembang, Macassar, Amboina). A separate sheet (*23a*) presents the six largest cities in Java — Batavia, Bandung, Semarang, Surakarta, Jocjakarta and Surabaya.

A point on which the compilers are to be congratulated particularly is the fact that the source of the data included is given on each map.

The topographical sheets are so detailed, that one need not hesitate to rely on them as a basis for intensive geographical study of the different islands. The student's work is further facilitated by the inclusion of a complete gazetteer listing all the names in the areas covered.

The whole work consists of thirty-one sheets. Only fourteen of these are occupied by topographical maps and material serving for the general geographic orientation of the reader; the rest — more than fifty per cent of the whole — are devoted to the cartographical presentation of technical and scientific data in various fields of study. Let us now consider briefly what points of special interest these pages have to offer the reader.

A fairly large number of sheets represent physical geography.

Map 3 is based on the results of the *Snellius Expedition* and depicts "the Seas of the Archipelago." The astoundingly capricious relief of the ocean bottom in the Eastern part of the Archipelago and southward of the Sumatra-Java-Timor zone is excellently brought out by the colours indicating the varying depths, 0—200, 200—1000, 1000—3000, 3000—5000 metres, etc. This map gives more than its title suggests, in that the orography of the islands is also indicated by coloured zones representing different altitudes of 0—100, 100—1000, 1000—3000 and higher than 3000 metres. The reader sees at a glance that, in the main, in the eastern regions the sub-marine relief is no less capriciously accidented than that of the dry land.

Map *4a* represents the Sunda Sea, between Sumatra, Java and Borneo, with the fossil rivers which drained this area, in the times when it was dry land during the last glacial period.

On sheet *4b* we find twelve well-chosen examples of coastal types and coral reefs in the Netherlands Indies — such as deltas and dunes, atolls, barrier reefs, and various others.

The very fine map on sheet 5 depicts the active volcanoes, the epicentres of earthquakes and the zones of positive and negative anomalies of gravity. Here we find the sub-marine relief once more indicated, which makes this map eminently suited for use in studying the possible connection between relief, gravity, earthquakes and volcanism. Sheet 6 presents examples of different types of volcanoes and of landscapes. There are eight maps devoted to the former and eleven to the latter.

The above-mentioned maps, all dealing with physical geography, offer no data which are essentially new, since the material covering the facts and phenomena which they depict had been treated in various technical journals and monographs before the publication of the Atlas. However, that part of sheet 7 which deals with botanical geography is entirely new. One is immediately struck by the enormous areas occupied by the different types of forests in Sumatra, Borneo, Celebes and New Guinea. Three little maps included on this sheet illustrate the distribution of certain plants or plant groupings. Nine other small maps indicate the habitats of certain mammals and mammalian groups; of birds of paradise, and of certain groups of fresh water fish. A d furthermore the compilers have included on this sheet fc ur charts showing the isobars and the wind directions for the months of January, April, July and November. The monsoon-dominated character of the climate in the East Indies is clearly illustrated here.

The meteorological charts are continued on sheet 8, where two small ones give the isotherms for January and July. These indicate clearly the "thermic rest" in the Archipelago in comparison to the adjacent parts of South-Eastern Asia and of Australia, where there is a contrast between very hot summers and moderately mild winters.

There are also small oro-hydrographical charts of some of the islands separately — Banka and Billiton *11g*; Sumatra *11f* and Java *15a*. It stands to reason that the data given on these charts are also to be found on the topographical maps, but on these special oro-hydrographical ones they stand out much more clearly. And finally there are rainfall charts of the four major islands: Sumatra *11c*, July and November; Java *15c*, January and August; Borneo *23d*, January and July; and Celebes, *23e*, January and August. It is interesting to note that the rainfall on Mount Chermai (*G. Tjermai* or *G. Tjareme*), a volcano in West Java, South of Cheribon, is more than 1000 m. in January.

Each of these physico-geographic maps is accompanied by an excellent explanatory letterpress; the phyto-geographical one is explained at some length.

To the maps depicting the facts of physical geography are linked one showing the distribution of minerals, valuable to all who are interested in mining, and several geological ones of various islands: Sumatra *11e*; Banka and Billiton *11d*; Java *15b*; Borneo, Celebes and the eastern part of the Archipelago *24a*; Surinam *31a*; and the Netherlands Antilles *31a*. In addition there is a map of Java showing the various types of soil.

The maps we have not yet mentioned are anthropogeographical, economic or historical. The one on population distribution (*8d*) illustrates the striking contrast between the greater part of Java with its more than 125 inhabitants per km² — see below — and the central portions of Borneo and New Guinea where we find 2 persons per km². On sheet *8e* are fourteen little maps illustrating as many types of human landscapes. Here we find interestingly illustrated how differently human dwellings are distributed

and located in various regions in the Indies, and these maps show very plainly the influence of the physical *milieu* on the lay-out of the village.

Sheet 9*a* gives a survey of the educational system. The reader will note with some surprise that Java, which is on the whole the most developed island of the Archipelago, does not show the highest percentage of school-going children, but is surpassed in this particular respect by portions of Western Sumatra, North Celebes, parts of the Moluccas and even by New Guinea.

On sheet 10 we find historical data — two maps of the whole Archipelago elucidating respectively "early history" and the gradual expansion of the Netherlands rule, and two maps of Java illustrating its earlier history and the Javanese principalities after 1525 A.D. In connection with these the reader should consult also sheet 24*b*, on which there is a chart showing the distribution of prehistoric finds, such as skeleton remains, microliths, neolithic and bronze articles, etc.

It is a well-known fact that the languages spoken in the Archipelago are very numerous. Map 9*b*, which only deals with the *families* of languages, numbering nineteen, brings out this multifariousness of tongues in a manner which will become even more striking when it is studied along with the excellent and more detailed letterpress accompanying this chart. Curious is the fact that certain groups of languages seem to settle along the coast — Malay in the western part of the Archipelago and the languages of southern Halmaheira and western New Guinea in the most easterly regions.

In the above we have confined ourselves to the anthropogeographical maps relating to the Archipelago in its entirety. Besides these there are a number of such maps dealing with different islands separately. Among these latter we may mention, in respect to Sumatra, a chart showing the principal agricultural and forest products based on export figures for the years 1929—1934, and a map of the well-known "Estates Area" in Eastern Sumatra (12*a*). Map 16*b* illustrates land utilization in Java, the accompaning graph indicating how comparatively small is the area covered by the European estates, that is, the agricultural enterprises financed by European capital and run under European management as compared to the area covered by native agriculture. Another map of interest is the one on irrigation (17*a*), from which we see how vast an area is furnished with water by means of various systems of aqueducts which call for technical engineering works and systematic management of the water supply. This map is supplemented by three additional ones (17*b*, *c*, *d*) representing certain types of irrigation works. Sheet 18*a* shows the density of the population in Java. One is struck by the fact that in 1930 — being the year of the census which supplied the data for this chart — several large rural districts supported more than 500 inhabitants per square kilometre. The communications map of Java draws our attention immediately to the fact that the island boasts no less than 25 air ports. There are also small maps showing the agricultural and forest products of Borneo (23*b*) and Celebes (23*d*).

Finally, there is an interesting map dealing with the population of Surinam. Here we see that the comparatively sparse population of this territory lives almost entirely along the rivers. The interior is practically uninhabited.

We have now reached the conclusion of our survey of the new atlas. Naturally this short sketch has become a mere summing up of the main points brought out in the atlas. Obviously the actual contents are infinitely richer and more comprehensive than it has been possible to indicate in the present article. In fact, the longer one concentrates his attention on any of the maps, no matter which, the greater the number of important details that emerge. One cannot help feeling that the editorial committee has managed to achieve the very best possible results. Few, indeed, are the points one might reasonably expect to find dealt with in the atlas which one does not find therein. In using the book the general reader will certainly not find anything missing. Of course the physical geographer and the anthropo-geographer will be able to think of subjects that might have been, but are not, taken up in this work; but in the main even they will undoubtedly be satisfied.

Those readers who are not familiar with the Netherlands language and with the official romanized rendering of the various native idioms from which the geographical names are drawn may have to contend with certain difficulties caused by the adoption — for obvious reasons — of a single system of transliteration. No solution of this ubiquitous problem in cartography has been found as yet and, therefore, it will have to be accepted as unavoidable in the case of this atlas too.

On the other hand the compilers have managed to meet the requirements of foreigners as far as possible. For these it will prove a great convenience that all titles and explanatory letterpress are given in four languages — Dutch, French, German and English.

May the present sketch of the contents of this work lead many readers outside the Netherlands to make use of it and thereby deepen their knowledge of the tropical territories of the Netherlands.

**The Pacific World Series:** — A special committee of the American Committee for International Wild Life Protection (consisting of FAIRFIELD OSBORN, Chairman, and HAROLD E. ANTHONY, WILLIAM BEEBE, ROBERT CUSHMAN MURPHY, EDWARD M. WEYER, Jr., and CHILDS FRICK [ex officio] some time ago undertook the preparation of a series of semi-popular books, dealing with the biology of the Pacific and Malayan region. An introductory volume "The Pacific World," edited by FAIRFIELD OSBORN, was published in 1944 by W. W. Norton and Co. of New York City. This is being supplemented by the following volumes, of which those marked with an asterisk have already been published: *"Birds of the Southwest Pacific" by ERNST MAYR, *"Mammals of the Pacific World" by T. D. CARTER, J. E. HILL and G. H. H. TATE, *"Native Peoples of the Pacific World" by FELIX M. KEESING, "Fishes and Shells of the Pacific World" by JOHN T. NICHOLS and PAUL BARTSCH, "Reptiles of the Pacific World" by ARTHUR LOVERIDGE, "Plant Life of the Pacific World" by E. D. MERRILL, and "Insects of the Pacific World" by C. H. CURRAN.

These volumes have been prepared primarily to meet with the wishes of members of the U. S. and other Allied Armed Forces in the Pacific area, many of whom are greatly interested in objects of natural history, the collecting and identification of plants and animals, etc., etc.† Cheap paper bound editions of these volumes are being made available by the (U.S.) *Infantry Journal*. Though semi-popular, there can be no doubt that these inspiring volumes will be of great use to amateur naturalists as well as professional biologists for decennia and decennia to come. Professional botanists will find the zoological volumes useful and the zoologists will find many data they could not obtain hitherto in a single volume in such a book as MERRILL's "Plant Life." When I went to Java as a bryologist in 1930, with the definite belief that I should devote 95% of my time to the hepatics, the remaining 5% would have been much more pleasant and I would have returned much less ignorant about things every biologist, whatever his specialty, should know, if I had had the use of such a series of biological baedekers. (F. V.)

**Lists of the Mammals of the Japanese War Areas:** — Dr. G. H. H. TATE, Associate Curator of the Dept. of Mammals of the American Museum of Natural History, has prepared four pamphlets, supplementing the "Mammals of the Pacific World" (*see above*), which contain especially much information about local geographical races and will not fail to be of interest to those concerned with the Malayan region. They may be obtained from the American Museum of Natural History in New York City; they were all published in 1944. Part 1 deals with "New Guinea and Eastward," Part 2 with "The Greater Sunda Area (Islands of the Northeast Margin of the Indian Ocean: Andamans, Nicobars, Sumatra, Java, Bali)," Part 3 with "Lesser Sunda Islands, Moluccas, Celebes," and Part 4 with "Borneo and the Islands of the China Sea."

**Nouvelles Etudes sur l'Agrologie et la Pédologie des Indes Néerlandaises†:** — L'auteur, un des spécialistes de l'Ecole Supérieure d'Agriculture de Wageningen, a entrepris en 1936 avec quelques étudiants et jeunes ingénieurs agronomes, un voyage à Java et Sumatra pour étudier des problèmes d'agrologie. Cette étude est exposée dans le présent volume qui constitue une monographie très complète et très claire de ce sujet complexe entre tous.

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* For a detailed account of the botanical activities of servicemen in the Pacific Area *see* CHRON. BOT. 9:135 (1945).

† C. H. EDELMAN 1941. Studiën over de Bodemkunde van Nederlandsch Indië, pp. 416 (Wageningen: Veenman: Publ. 24 "Fonds Landbouw Export Bureau 1916/18") fl. 4.70.

Après un court aperçu des recherches effectuées avant 1900 par des précurseurs, l'auteur montre que c'est seulement au début de ce siècle, notamment sous l'impulsion de MOHR, que commença l'étude de l'agrologie théorique. C'est de 1909 que datent les premières publications détaillées de cet auteur sur les sols de Java et Sumatra.

Dans les chapitres suivants, EDELMAN décrit la constitution des sols du point de vue physique, minéralogique et chimique; il montre leur teneur en eau, leur perméabilité, la présence et le rôle joué par les microorganismes; il étudie les facteurs qui ont une influence sur les propriétés du sol: le climat, la topographie, la faune et la flore, les cultures; puis il expose la nomenclature et la systématique des sols et ce qui a été fait pour l'établissement de cartes agro-géologiques; il parle des recherches poursuivies dans les laboratoires et sur le terrain, des méthodes utilisées au cours des investigations (analyses chimiques et mécaniques), des applications d'engrais, etc.

Dans quelques chapitres, qui occupent d'ailleurs plus de la moitié du texte, l'auteur traite les différentes cultures en relation avec le sol et rappelle les efforts qui ont été faits pour améliorer le terrain en vue de cultures déterminées; il s'occupe ainsi successivement du riz, du sucre et du tabac, puis des cultures persistantes: café, thé, caoutchouc, quinquina, cocotier, palmier à huile, agave et manioc; enfin, il traite de l'agrologie des forêts. Dans les derniers chapitres, l'auteur étudie l'irrigation et l'érosion dont le rôle peut être tout particulièrement néfaste dans les régions tropicales à pluies torrentielles; enfin, les rapports qui existent entre la nature du sol d'une part, les maladies des plantes et la sélection des végétaux de culture d'autre part, font l'objet d'un chapitre fortement documenté.

Un index bibliographique qui occupe 106 pages, avec une moyenne de 24 titres par page, montre l'importance des recherches faites aux Indes Néerlandaises dans le domaine de l'agrologie. Très ingénieusement, l'auteur a groupé cette bibliographie en trois périodes: celle des précurseurs de 1850 à 1899, puis de 1900 à 1925, enfin la période moderne de 1926 à 1940.

Une partie très importante du livre consigne ce qui a été fait dans le domaine des engrais et surtout des engrais verts qui ont été activement propagés par les stations expérimentales; c'est une des questions les plus importantes de l'agriculture tropicale, puisque ces cultures accessoires (en général les légumineuses) améliorent le sol chimiquement et physiquement, combattent l'érosion et protègent les plantes et le sol contre la brûlure des rayons du soleil.

Ce remarquable ouvrage est de grande importance pour tous ceux qui, par la suite, s'occuperont d'agrologie, non eulement dans les contrées tropicales, mais dans tous les pays. Au cours de son voyage, l'auteur a pu se documenter abondamment sur un sujet qu'il connait fort bien et qu'il expose de façon intéressante et instructive.

Il rend hommage à tous ceux qui, aux Indes Néerlandaises, ont travaillé à l'avancement de l'agrologie et qui ont contribué au progrès des cultures: les chefs des laboratoires d'agrologie du Département de l'Agriculture, le personnel des stations expérimentales pour le sucre, le thé, le tabac, le caoutchouc, etc., qui ont mis au point les diverses cultures; enfin, les planteurs qui ont apporté la contribution de leur expérience pratique.

Ce livre est écrit en Hollandais; la presque totalité des ouvrages cités dans l'index bibliographique sont en Hollandais; on pourrait le regretter car cela nuira peut-être à la diffusion des observations faites, des idées émises dans ce volume; mais cela montre du moins le merveilleux travail accompli par les Hollandais en matière d'agriculture tropicale, tout ce qu'ils ont fait dans le domaine de l'agrologie comme dans d'autres domaines, grâce à l'excellente organisation de leurs services agricoles, à l'intelligente collaboration des laboratoires scientifiques du Département de l'Agriculture et des Stations expérimentales avec les hommes de la pratique, qui ont porté les cultures, tant de la population indigène que des plantations européennes, à un niveau qui peut-être n'a été atteint nulle part ailleurs. (CH. BERNARD *in Rev. Int. Ind. Agric.*)

**The Netherlands Indies in the Twentieth Century** *: — Published at a time when Holland was completely cut off from her Overseas Territories, and only a few weeks before the Japanese attack on Pearl Harbor and the subsequent Netherlands declaration of war on Japan, this book gives an up-to-date (1939) and objective survey of the Netherlands Indies in the 20th century. Its title "A great task achieved" is rightly derived from the prophetic words of Governor-General JAN PIETERSZOON COEN: "A great task can be achieved in the Indies." In spite of its title this book is not a one-sided self-glorification of Dutch achievement. It does not show Netherlands nationalistic bias. The many contributors do not condone nor gloss over the mistakes made in the distant and recent past. However, its aim is to show, Dutchmen and foreigners alike, what Holland did to bring peace and prosperity to this overseas part of the Kingdom.

In the Indies, backward and advanced stages of human evolution and cultural development have persisted, side by side through the ages and are still present today. The beliefs and customs inherent in primitive society, the survivals of Hindu thinking and culture, the predominant force of Islam and the results of four centuries of Western influence and enterprise are still jointly involved in a process of sublimation and integration, the provisional outcome of which has been the Indies of the last decade. It is, therefore, not possible to arrive at a proper understanding of the modern development of these territories without going into a historical discussion of the ethnology, anthropology, and sociology, or of the racial, linguistic, religious, economic and political structures of the present day Indies. It is with this historical background in mind that the authors have approached their subject.

The book begins with chapters on the ways and means of travelling between the motherland and the Indies in past and present by J. C. MOLLEMA, LEONHARD HUIZINGA and HANS MARTIN. Starting with the first expedition under DE HOUTMAN in 1595 — a two and a half years trip out and home — descriptions are given of the monopolistic period of the East Indian Company, and of the opening of free traffic in 1816 after the establishment of the Netherlands Kingdom. Interesting is the account of passenger-life on the great sailing-vessels which even in 1882 still needed 115 days for a one way trip. In 1871, shortly after the opening of the Suez Canal, steam navigation was introduced with a small ship of 2500 tons. After the first world war huge luxurious liners of 20,000 tons had reduced the crossing to sixteen days, whereas since 1937 there existed a regular air service between Amsterdam and Batavia with a schedule of three times per week shortening the journey to 5½ days. The authors rightly emphasize the importance of this development for an increased unity and a further strengthening of the cultural, social, economic and political ties between Holland and the Indies which, as far as distance is concerned, virtually have become neighbors.

In the chapter "From Coen to van Heutz" the gradual transformation of the East Indies into the Netherlands Indies is told. The author, Dr. F. W. STAPEL, gives a vivid picture of the early days of the Dutch in the Indies.

It was not lust for conquest which aroused the Dutch. Direct trade, excluding the Portuguese middlemen, the wish to avoid Portuguese ports because of the Spanish-Dutch war and the newly gained knowledge of the sea-routes to the Far East, were some of the causes of Dutch settlement in these islands. The monopolistic United East Indian Company was founded in 1602, at the instigation of JOHAN VAN OLDENBARNEVELDT. He realized the danger of deadly mutual competition between the Dutch merchants as against the strongly centralized Portuguese colonial trade which was an exclusive prerogative of the Portuguese crown. The directors of the company frequently defined its aim as: "Exclusion of competitors, to buy cheap and to sell dear." In spite of these purely commercial aims the Company was soon forced to exercise its rights of sovereignty which it had

* Daar werd wat groots verricht. — Nederlandsch-Indië in de XXste eeuw, *edited by* W. H. VAN HELSDINGEN and H. HOOGENBERK (Amsterdam: N. V. Uitgevers-Maatschappij "Elsevier," Pp. 528, 1941).

received in behalf of the States-General of the Netherlands. The continued warfare against Spanish, Portuguese, British and French competitors, the establishment and protection of its settlements and factories, the necessity of concluding treaties and pacts with the native princes and the ever increasing territorial expansion made this indispensable.

It is a disputable question whether the history of a nation is the history of its leaders or whether these leaders are the living exponents of the wishes, spirit and destinies of the people. However, it is certain that the Company in its early history had the right men in the right places, who shaped the destinies of the Indies for ages to come. Dr. STAPEL makes this clear in his excellent short biographies of the great governors-general, in particular of JAN PIETERSZOON COEN, the founder of the Dutch East Indies Empire. COEN carried on the struggle against the English and other European competitors, he pacified the scheming Sultan of Bantam, he founded Batavia on the ruins of the ancient city of Jacatra, he consolidated the monopolistic spice trade, he subdued hard-handedly the recalcitrant Bandanese, he organized the government, administration and justice of the conquered territories and gained a lasting foothold for the Dutch in the Indies. His able successors, VAN DIEMEN, MAETSUYCKER, SPEELMAN, VAN IMHOFF, MOSSEL and others continued what COEN had begun. The author describes the "modernizing of Batavia," the conquest of Malacca, the expansion of Dutch rule or influence over various territories of the Indies, the recognition of the Company as a "Great Power," the introduction and cultivation of new agricultural products, the gradual decline of the Company in the 18th century owing to the rise to power of the English and French colonial empires and the personal corruption o many of its officials. In particular the section on the trade of the Company and the cultivation of new products is illuminating. Apart from the various spices these included coffee, tea, sugar, camphor, lac, wax, vegetable dyes, opium and precious kinds of wood; moreover the Company traded in diamonds, tin, gold, silver and copper; in textiles, silk, and even in Ceylonese elephants, horses, saltpeter, Persian wines, pearls, perfumes, medicines, precious chinaware and ethnographic curiosities. The history of these products with their social, economic and political implications makes interesting reading. The section on the 19th century describes the period of the Batavian Republic under the leadership of DAENDELS, who improved government, justice and defense; the British interregnum under RAFFLES; the return of the colonies to the Netherlands in 1816; the economic dislocation of that period, the Java-war under DIPO NEGORO, the introduction of the culture system in Java by VAN DEN BOSCH, the financial advantages of that system for the motherland, the resulting impoverishment of the native population, the resistance it aroused in Holland and its gradual abolishment; the neglect of the Outer Territories; the conquest of Sarawak by JAMES BROOKE in 1841, the gradual extension of Dutch authority over the Outer Territories and the final pacification of these territories by Governor General J. B. VAN HEUTZ, of whom it is rightly said that he completed COEN's work.

The chapter "The Indies in Asia" by Professor F. C. GERRETSON largely supplements the previous chapter. The author observes that from ancient antiquity on the economic position of the Indies in Asia was subordinate to its relations with Europe. Situated below the south-east corner of the Asiatic mainland and separating the Indian Ocean from the Pacific it became in ancient times a (passive) "rendez-vous" where traders of the Middle- and Far East met each other. Describing the Chinese settlements, the Hindu-Javanese empires (Singasari etc.), the establishment of a new Malay center of trade in Malacca, the gradual islamization of the coastal regions of Sumatra and Java, the author shows the importance of the spice trade, which in the 15th century came entirely in the hands of the Arabs, from Malacca to Alexandria. The Arabs were succeeded by their implacable enemies the Portuguese, who started monopolizing the trade between the Indies and China. The Portuguese were succeeded by the Dutch who shifted the center of commercial gravity from Malacca to the Archipelago itself. In contrast to general colonial historiography Dr. GERRETSON maintains that after the expulsion of the English the East Indian Company became the first great European territorial power in the East, with Batavia as emporium. In the course of time Batavia obtained a double function; it became the center of a limited export of (luxury) products to Europe and the center of an unlimited general Asiatic trade. This Asiatic trade was indispensable for obtaining the import goods to the Indies which the homeland could not deliver, but was particularly carried on "in its own right" because of the large profits to be gained. The author gives a lucid description of the trade between India and China via Batavia (opium and tea), and of the advantage of a combination of trade monopoly within the Archipelago and free trade outside the Indies, which lasted till the second half of the 18th century when the British established their own monopolies in India. This development was the undoing of the Company. The lesson to be learned was that a colonial trade organization which does not in the first place depend on the products of its own territory cannot last. The lesson was learned in the 19th century when the center of gravity shifted from trade to agriculture, and the Indies became an export market for the world. The author concludes with the remark that Netherlands rule gave the Indies its place in Asia rather than depriving it thereof.

The chapters "People and Land" and the "Cultural Treasures of the Indies" are devoted to the ethnology, anthropology, religion, culture and social conditions of the native peoples of the Indies. Referring to the unbroken continuity up till present times of the influence of pre-historic civilization in the Indies, Professor VAN VUUREN traces the development of (*1*) the prehistoric period, (*2*) the period of antiquity, (*3*) the Middle Ages and (*4*) the modern period. To the first belong the migration of the proto-Malays from South China and Further India, the gradual sedentarization and differentiation of these Malays and their cultural forms of the middle and later stone and bronze ages, such as irrigation, rice cultivation, megalithic monuments, stone axes, decorative architecture and worship of spirits and ancestors; the second period includes the new immigration of the aristocratic Coastal-Malays who were navigators and traders and superseded the early Malays, and the first trade-contacts with China and India; the third comprises the introduction of Hindu civilization, its gradual acculturization into indigenous Hindu-Javanese forms, the rise to power of the great Hindu-Javanese empires, and the introduction of Islam from India; the modern period finally begins with the arrival of the Portuguese who were followed by the Dutch and the other Europeans. The author traces the European influence on the social, economic and religious life of the various native groups.

In view of the rôle which China is certain to play in the future development of the Far East as a whole, the section on the "Chinese" by Mr. BRUINEMAN deserves special attention. According to recent estimates there are about one and a half million Chinese in the Indies. In contrast to the Japanese the Chinese came already in early times to the various islands as traders, adventurers and founders of small transient independent states. The author gives a picture of their important economic position, especially in Java, as middlemen and traders, and of the decline of that position largely owing to the rise of Japanese commercial influence n the 20th century. In the Outer Territories the Chinese immigrants were mostly employed as workers in the mining industries. With the mechanization and modernization of these industries in addition to the influx of Javanese workers, this Chinese immigration came to a standstill. Although the Chinese never submerged in native Indonesian society and always kept the cultural and economic ties with China intact, there is no inclination on their part to return to the homeland. They became Indo-Chinese. Mr. BRUINEMAN describes their complaints against the Dutch government who in the 19th century conducted an unwise Chinese policy, and their gradual emancipation which, to a certain extent, is a reflex of the events in China itself under SUN YAT SEN. This emancipation gave the Indo-Chinese an excellent modern educational system which opened opportunities for them in the fields of medicine, engineering, law and other branches of scientific activity. As such the Chinese became serious competitors for the Europeans, whereas they do no longer hold their unique commercial position. Mr. BRUINEMAN sees in this development of better education for Chinese and Indonesians a gradual elimination of the traditional social differences between the Europeans and the various native racial groups.

The chapter "People and Land" concludes with sections on the "Indonesian Village" and the "Indian Town" by Professor V. E. KORN and Dr. D. DE JONGH respectively. Professor KORN describes the magic structure of the various types of "desa" in the Indies, their social life based on adat (customary law), their closed economy, in modern times superimposed by the western money-economy, their significance for the government as basic units of native life, the

mistakes made by the Dutch government with regard to the modern organization of the "desas" and the advantages of this organization such as popular education, credit systems and a general welfare policy. Describing the origin, history, population, traffic, function, government, public services and modern development of the towns, Dr. DE JONGH observes that in our times these towns favorably compare with other tropical cities thanks to legislative, hygienic and technical measures. They are very well equipped for their tasks of governmental, economic and traffic centers, but failed till so far as spiritual and cultural centers.

Although approximately 90% of the native population profess the Mohammedan faith and some 2,000,000 are Christians, the primordial magic conceptions of primitive religion are still a dominant force in Indonesian life. This is clearly expounded by Professor H. TH. FISHER in his article "Paganism and Popular Religion," the first section of the chapter "Cultural Treasures of the Netherlands Indies." The author differentiates between Islam and Christianity which he calls the religions of the future for the Netherlands Indies, and the native popular religion which he defines as a not officially recognized continuous complex of beliefs and practices incompatible with the above mentioned religions of the people. He mentions, however, the mutual interaction and the various types of popular religion which are the result of that interaction. The popular religions of Ambon and Java, *e.g.*, show traces of Ambonese Christianity and Javanese Mohammedanism. The communion wine which becomes a medicine, the words of the Koran which serve as a talisman are striking examples of this. In this manner the cultural and ethnological history of the people can be traced through a study of their religious forms. Professor FISHER illustrates this by a description of the religio-magic aspects of native agriculture, house-building, ornamentation and religious art; the rites and taboos of fertility, marriage and death, etc. He rightly quotes ADRIANI, who said that for the native religion is something which is given with existence and belongs to life.

Professor J. GONDA gives an excellent philological survey of the "Diversity of Native Languages and Literature." This diversity is extremely complex. On thinly populated Celebes alone, *e.g.* twenty-five languages are spoken. The author describes the distribution of the many languages over the various islands and it appears that this distribution does not always correspond with the native habitat of the languages. The Buginese reside in the south-west of Celebes, but their language is also spoken along the northern coastline of the island. Trade and colonization explain this phenomenon and this goes for many Indonesian languages, in particular Malay, which became the lingua franca for the Indies, the language of Christendom in the "Great East" and that of Islam elsewhere. Professor GONDA, describing the social connotations of the use of High and Low Javanese, illustrates his article with numerous grammatical and idiomatic examples showing the peculiarities, similarities and relationship of the Indonesian languages, which presumably were derived from one common language in pre-Christian times, spoken in the coastal regions of Further India. Moreover, he shows the foreign influences of Sanskrit, Arabian, Persian, Portuguese and Dutch. A large part of his article is devoted to the literature of the Indonesians, in particular of the Javanese, including the ancient "proverb" literature, the folk songs, the animal stories, the mythological tales, the great Hindu epics with their Old and Middle Javanese versions, of extreme importance for the wayang plays, etc. The author concludes with a description of the decline of native literature in the 18th century, its revival in modern times and the introduction of new forms such as native journalism. In particular the work of the Office for Popular Literature, established by the government in 1908, has been of great educational value. It has been responsible for translations of numerous European literary works into the native languages, it has spread western knowledge among the population. Moreover it stimulated the production of original literature in the native languages.

The "Cultural Treasures" conclude with articles by Dr. TH. P. GALESTIN on "Aspects of Native Art" and Professor F. D. K. BOSCH on the "Care of Ancient Cultural Treasures." The former presents a good review of the historical development of native art forms and their integration in the religious and social life of the people from pre-historic times through the Hindu-Javanese and Moslem periods up till present times. As such Dr. GALESTIN's article supplements the articles by Professor GERRETSON, VAN VUUREN, KORN and FISHER. From these articles it becomes clear that the many peoples of the islands still exhibit in their cultures the predominant traits of the civilization which have existed in the past. The preservation of the cultural monuments they have produced is, therefore, of more than academic interest. It is essential not only for a knowledge of the past, but also of the present situation. Although a beginning was made in the 19th century, it was only in the 20th that the government showed an increased interest in the study of Indonesia's antiquities. Dr. BOSCH describes the establishment of an archaeological commission in 1901 under Dr. BRANDES who analyzed the problems, devised the methods and laid the foundation for the subsequent archaeological investigation; the restoration of the Borobudur in 1907 under TH. VAN ERP, the creation of the Government Archaeological Service under Dr. N. J. KROM in 1913 which in the following years has been responsible for the restoration and reconstruction of the great Hindu-Javanese monuments, and the Chinese, Mohammedan and Dutch antiquities. Its extremely important work has been exemplary for other colonial regions. Dr. BOSCH rightly observes that the simple fact that the care for old cultural treasures is not productive in a sense of producing material gains may serve to indicate the high ideals which have marked the Netherlands overseas administration in the past forty years.

The following chapter "Government and Islam" by Professor W. J. A. KERNKAMP gives an outline of the Dutch Islam policy during the period of the East Indian Company and in the 19th and 20th centuries. Although according to its statute of 1602 it was the duty of the Company to take care of "the progress and propagation of the true Christian religion" — a policy to which it adhered within its settlements — the Company was primarily concerned with its commercial interests and not with the spiritual welfare of the natives. Mainly for that reason they were tolerant. The author suggests that it might have been better if the Company had gradually Christianized the entire population even "with force." In that case there would have been no fear of Pan-Islamism, no Holy War, no trouble with *hadjis*, no enslaving of the people by narrow-minded Moslem theologians, no polygamy, no outcasts, etc. In the subsequent pages Dr. KERNKAMP gives a description of the problems arising from these factors. Islam, besides being a religion is also a social system with laws including all kinds of provisions with regard to the form of government. In this respect it is peculiar that only in the late 19th century a thorough knowledge of Islamic law in all its implications was obtained through the eminent work of C. SNOUCK HURGRONJE. The Islam-policy of this scholar differentiates between the dogmatic and eschatological aspects of the Mohammedan religion on the one hand, and its political character on the other. The former should at all times be free (with certain restrictions as in the case of Mahdi-expectations), the latter pertaining to such matters as the Caliphate, Pan-Islamism, and Holy War etc. was to be brought under control. This policy was accepted by the government and carried on till the Japanese invasion. The author concludes with a description of the government measures for the pilgrimage to Mecca (Hadji), religious jurisdiction and penghulu-courts; Moslem religious education and the government subsidies to schools "with the Koran" and the work of the Office for Indonesian Affairs, established in 1899.

In the chapter "The Significance of Christianity" Professor H. KRAEMER writes on the Protestant Mission and Dr. L. VAN RIJCKEVORSEL, S. J. on the Catholic Mission. Describing the basic mission and task of Christianity as bringing spiritual salvation to humanity, Professor KRAEMER proceeds with a historical survey of the spread of Protestantism in the Indies. At present there are more than 1½ million Indonesian Protestants very unevenly distributed over the various islands. The oldest Christian center is Amboina and the Moluccas which had already been partly Christianized by the Portuguese before the E. I. Company took over in 1605. Even today Amboina is a reserve depot for pioneers and auxiliary forces in the domain of Mission and Education. Its autonomous church comprises 200,000 members. Other important centers are Northern New Guinea (60,000), the Minahassa in Northern Celebes (400,000), the Dyak Church in South-East Borneo (12,000), the Batak Christians of Sumatra (400,000), Java (70,000), the Timor Archipelago (150,000) etc. Since 1930 most of these groups became organized in autonomous churches, although incorporated in the Indian Church which was originally founded as a State Church by King WILLIAM I and at present includes the Church Union of European

Protestant Christians and the above mentioned various autonomous Indonesian Churches. In 1935 the most important event of separation of Church and State in the Indies was effected giving the Indian Church freedom in its actions. Professor KRAEMER gives an informative survey of the Dutch and foreign missionary societies active in the Indies, of the scientifically trained work of the Netherlands Bible Society and of the extensive social work of these societies. It certainly speaks for the progressive development of the Indonesian Churches that they have increasingly taken over the tasks of the European missionary societies. Dr. RIJCKEVORSEL gives a survey of the work among the Catholic Europeans which began in 1808 and gradually grew into a mission among the native population. How successful and intensive this work has been can be gathered from the figures the author gives: in 1870 there were 11,000 Indonesian Catholics, in 1900: 26,000 and in 1920: 72,000. In 1930 there were 233,000 and in 1939 their number had reached the impressive total of 478,000, the majority of whom are concentrated in the islands of Flores and Timor. Important is the educational and social work of the Catholic Mission. Before the Japanese invasion there were 1600 Catholic schools with more than 142,000 pupils and 4000 teachers.

Professor GERARD BROM writes on "Dutch Art and the Indies." From his article it appears that during three centuries of Dutch Indonesian union the Indies hardly exercised any influence whatsoever on Dutch art. This phenomenon is certainly indicative of the spirit in which the Dutch approached the Indies during that period. MULTATULI was really the first who was able to unite "the soul of the Indies with the heart of Holland." It was only in the 20th century, when the Dutch became positively conscious of their moral obligations toward the Indonesian people that they also became aware of the beauty of these territories. Dr. BROM gives an outline of the manner in which this new approach affected Holland's painters and authors and concludes with the remark that a truly worthy presentation of the Indies by them still belongs to the future.

"Victory over Distance," on the seas, on land, in the air and in the ether is a joint chapter written by Dr. J. C. WESTERMANN, S. A. REITSMA, HANS MARTIN and A. VAN DOOREN. It gives a survey of the extremely important development of the interinsular navigation; road and railroad traffic; aviation, and the radio in its various applications such as telegraphy, telephony and broadcasting. This chapter is important because it presents the significance of these modern means of communication for the integration of the Netherlands Indies into one economic and political unit. In this respect it may be mentioned that before the war there was a network of roads comprising 69,000 KM, and of rail- and tramways comprising 7400 KM; there were 11 airlines between the islands, including Australia and numerous radio-stations for telegraphy and telephony with main centers in Batavia, Macassar and Amboina. In 1939 the Netherlands Indies Radio Broadcasting company operated 28 senders with continuous programs for both the Dutch and the Indonesian population.

The following chapters contain a wealth of information on the modern development of the Indies in the fields of technological and economic enterprise; growth, care, welfare and education of the population; general Dutch policy and administration, politics and religion, jurisdiction and international trade. They certainly reflect the spirit of the Dutch policy as formulated in 1901: "As a Christian power the Netherlands is obligated to permeate the conduct of the government in all its aspects with the consciousness that it has to fulfil a moral task with regard to the population of these territories." These excellent chapters are so comprehensive that they cannot be adequately summarized in this review. However, the following points will suffice to show their importance.

In the section "The Struggle for and against Water" Professor H. C. P. DE VOS writes on irrigation, the alpha and omega of all agricultural enterprise in the Indies. Mentioning the insufficiency of the so-called "ladang," the freshly cleared forest lands for the production of food, the transition of dry to wet rice-cultivation and the technical problems involved in that transition, he gives a technical description of the modern government control of irrigation, since 1888 organized in divisions each comprising hundreds of thousands hectares. The problems of cartography, pump-irrigation, drainage, equal distribution of water, river control etc. indicate the difficulties the government had to cope with. How important this work is for the ever growing population of Java can be seen from the following figures: from 1900 to 1940 the flooded fields were extended from 2,700,000 HA to 3,350,000 HA; the dry fields from 2,900,000 HA to 4,600,000 HA. In that period the government spent 270,000,000 guilders on irrigation, including the installations for electrical power and drinking waterworks.

An article by Professor G. A. TH. WEYER is devoted to the great western agricultural enterprises of which there were on Java 1200 comprising 600,000 HA and in the Outer Territories combined also 1200 with a total area of 575,000 HA. In 1939 they produced 2¼ million tons of various products with a trade value of 300,000,000 guilders. More than 1¼ million native workers were employed by them alone. According to the author approximately 2 billion guilders were invested in these enterprises. In 1938 the workers earned more than 100 million guilders, being 33% of the total export value. Professor WEYER shows convincingly that Western agricultural enterprise did not infringe upon native agriculture, but rather stimulated it. Such products as coffee, tea, quinine, sisal, coco, oilpalm, rubber and many others were all introduced from foreign tropical regions. The author gives a description of the cultivation of these products, of the labor problems involved, of the governmental measures, such as the Agrarian law of 1870, labor inspection, medical care, education and hygiene, of the experimental research stations and of the "important social-economic function of the great cultivations as an indispensable complement of the present economic development of the Indies and its population."

In "The Winning of Underground Treasures" by Dr. T. HÖVIG, it is said that in 1938 the total commercial value of mineral production amounted to 280 million guilders. In the mining industry 3000 employees and more than 60,000 workers were employed. The products included tin, gold, silver, bauxite, manganese, phosphates, sulphur, diamonds, coal, mineral oil and gas, asphalt limestone as well as small amounts of copper, nickel, platina etc. The author gives a lucid exposition of the geological structure of the Indies soil, of the location and exploitation of the various products, and of the big mining companies and the government share in the mining production. In 1938 there were extant 114 claims for the exploitation of diverse ores, 160 for petroleum and other bituminous products, 29 for coal, 9 for other minerals and 148 for various building materials.

The forest service in the Indies has a staff of 4000 people, including a chief inspector, 15 inspectors, 116 academically trained foresters, 600 officials and more than 3000 workers. In 1933 this service provided work for 17 million man-days per year on Java alone. These figures hardly express the extreme importance of the preservation of the Indies woods with regard to soil fertility and general agrarian production as described by Professor A. TE WECHEL in his article "The Indian Forests." The total wood area comprises more than 120 million hectares, of which a great part can be converted to native arable land or western agriculture. In view of soil erosion, however, this conversion must remain under strict control. The author describes the mistakes made in the past and the governmental measures of the 19th and 20th centuries, including reforestation of mountain slopes, wood reservations, etc. Reforestation in particular influenced the production of irrigation water and as such agriculture. The exploitation of Javanese teakwood yielded great results, with netto profits of 5 million guilders per year before the conomic depression of 1929. Java is far ahead of the Outer Territories, but there also much headway has been made.

In the course of approximately 140 years the Javanese population increased from 4 to 44 million people. In the chapter devoted to this phenomenon Professor J. H. BOEKE gives a critical analysis of the causes and resulting problems of this development. There are two factors which determine the Javanese population problem: on the one hand a culturally and economically stagnant and static native society with no essential changes in the means of subsistence of the population and based on small-farming with food production of the traditional crops (rice etc.) for home-consumption; on the other hand an annual increase of approximately 500,000 with possible impoverishment, undernourishment and decreasing resistance. Moreover, owing to western influence, and the introduction of money economy there is a dislocation in the closed community economy of the desas. The population is in need of money for taxes and those necessaries of life (salt, fish, oil, tobacco etc.) which are not produced by the desas. Before the economic depression the main sources of income were labor on the western en-

terprises and the leasing of ground to these enterprises. After the depression these sources were largely reduced with a resultant danger of increased indebtedness or forced food sales. The author discusses the various government measures to ease this situation. They include irrigation which in Java has reached its limits; the promotion of the cultivation of second crops, agricultural information and education, the provision of better sowing seed, the introduction of new varieties, the use of artificial fertilizers, the cultivation of commercial crops, industrialization and colonization. These measures, however, have all their limitations and are not sufficient in themselves to solve the intricate problems. The best results are to be expected from emigration. A most efficient organization made an annual colonization of 50,000 selected settlers in the Outer Territories possible where they received the utmost care for their future existence.

The chapter "Care of the Population" opens with a section on "Native Agriculture" by Dr. G. J. VINK. How important this is can be gathered from the following figures; it feeds virtually the entire 70 million population; it is responsible for an export surplus of tropical products for the world market amounting to one fourth of the total export from the Archipelago. In the bad year 1938 indigenous agriculture provided 18% of the exported rubber, 95% of coco products, 58% of coffee, 83% of capok and 99% of pepper. The total value of native export products amounted to 173 million guilders in that year, an important decrease as compared with the pre-depression figures. Dr. VINK ably describes the character and various types of native agriculture and the many tasks of government care which are too extensive to be mentioned here. This is also the case with the excellent article by Mr. TH. A. FRUIN on the popular credit system which the author describes as "a support for the population to keep its head above water and to help those who became entangled in debts. Moreover, it is a valuable instrument for the government and its welfare services to carry into effect various special measures in the interest of general popular welfare." The author describes the establishment of the General Popular Credit Bank (A.V.B.) in 1934, which controls the various village credit institutions, its organization and tasks, the gradual growth of native coöperative societies since 1927 and the unsolved credit problems arising from the fact that the village still lives in a pre-capitalist desa economy while being ensnared through his inevitable expenditures in the capitalistic money economy with which he is not acquainted.

The remaining chapters deal with the increasing development of industry in recent years by Mr. CECILE ROTHE; sanitation and nourishment by Professor C. D. DE LANGEN; social welfare by Mr. J. TIDEMAN and spiritual welfare and education by Professor J. H. BAVINCK; Incentives for the development of the Indies by Professor H. A. IDEMA; The Press in the Indies by Dr. C. W. WORMSER; Political and religious political movements by Mr. E. GOBÉE; the Central and Regional Administrations by Dr. W. H. VAN HELSDINGEN; the Indian Civil Service by R. K. A. BERTSCH; Law and Jurisdiction by Professor H. A. IDEMA; the Netherlands Indies as purveyor for the worldmarket and as consumer by Dr. J. DE WAARD; the Netherlands Indies in figures by Professor N. G. TINBERGEN and Dr. J. B. D. DERKSEN and a conclusion by Dr. VAN HELSDINGEN.

The struggle against tropical diseases; medical research; dietetics and hygiene; social measures with regard to colonization, prostitution, criminality, after-care of prisoners and poor-relief; temperance and the fight against opium, are some of the factors which give a picture of the intensive work for the social welfare of all groups of the population; the fight against illiteracy, the introduction of the desa-school, the development of the European, Dutch-Indonesian and Dutch-Chinese schools, the various vocational schools, the link-schools connecting Dutch and Indonesian education, the position of the Taman-Siswo schools and the gradual extension of university tuition give a survey of the important progress in the educational field; the political and economic events of the last decades leading up to the progressive political emancipation of the Indonesians and other Asiatic groups, the establishment of the People's Council (Volksraad), the reorganization and decentralization of the government, the introduction of regency and provincial councils, the ever expanding share of the Indonesians in the administration, the intricate economic problems arising from the economic depression of 1930 and their solution, were conducive to a growing autonomy for the Netherlands Indies.

It speaks for the spirit of the Dutch that they were able to produce this admirable book under the strenuous conditions of the Nazi occupation. In December 1942 Queen WILHELMINA announced the plans for the creation of a Commonwealth of the Netherlands, Indonesia, Surinam and Curaçao "on the solid foundation of complete partnership, which will mean the consummation of all that has been developed in the past." That these plans are truly the consummation and culmination of a long period of development finds a striking proof in "A Great Task Achieved." (D. FRIEDMAN, Netherlands Information Bureau, New York City.)